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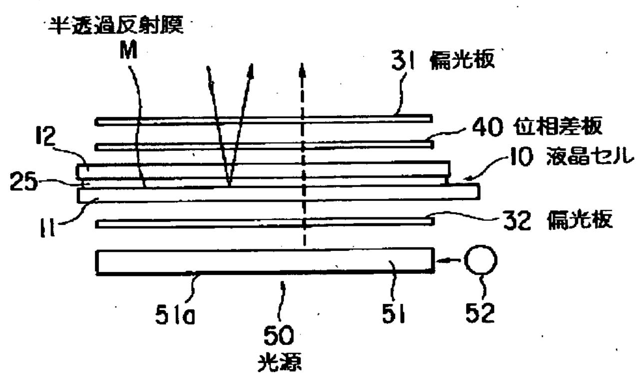
(54)【発明の名称】　液晶表示装置

(57)【要約】
【目的】外光を利用する反射型表示機能と光源からの光を利用する透過型表示機能とを有する液晶表示装置として、外光を利用する反射型表示の際の偏光板および液晶セルの基板での光吸収による光量ロスを少なくし、反射型表示での表示を十分明るくすることができるものを提供する。
【構成】液晶セル１０の表面側に第１の偏光板３１を配置し、前記液晶セル１０の裏面側に第２の偏光板３２を配置するとともに、前記液晶セル１０の裏面側基板１１の内面に、入射光をある反射率と透過率で反射および透過させる半透過反射膜Ｍを設け、前記第２の偏光板３２の背後に光源５０を設けた。



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【特許請求の範囲】
【請求項１】外光を利用し表面側から入射する光を反射させて表示する反射型表示機能と、光源からの光を裏面側から入射させて表示する透過型表示機能とを有する液晶表示装置であって、
表裏一対の透明基板間に液晶を挟持させた液晶セルと、この液晶セルの表面側に配置された第１の偏光板と、前記液晶セルの裏面側に配置された第２の偏光板とからなり、
かつ、前記液晶セルの裏面側基板の内面に、入射光をある反射率と透過率で反射および透過させる半透過反射膜が設けられていることを特徴とする液晶表示装置。
【請求項２】液晶セルの両基板の内面にはそれぞれ液晶層に電界を印加するための電極が設けられており、裏面側基板の内面に設けられた電極が半透過反射膜を兼ねていることを特徴とする請求項１に記載の液晶表示装置。
【請求項３】液晶セルは、裏面側基板の内面に複数の画素電極とこれら各画素電極にそれぞれ対応する複数の能動素子を配設し、表面側基板の内面に前記各画素電極と対向する対向電極を設けたアクティブマトリックス型セルであり、前記画素電極が半透過反射膜を兼ねていることを特徴とする請求項２に記載の液晶表示装置。
【請求項４】能動素子は保護絶縁膜で覆われており、半透過反射膜を兼ねる画素電極は前記保護絶縁膜の上に前記能動素子を覆って設けられて、前記保護絶縁膜に形成したコンタクト孔において前記能動素子に接続されていることを特徴とする請求項３に記載の液晶表示装置。
【請求項５】液晶セルは、表面側基板の内面に複数の画素電極とこれら各画素電極にそれぞれ対応する複数の能動素子を配設し、裏面側基板の内面に前記各画素電極と対向する対向電極を設けたアクティブマトリックス型セルであり、前記対向電極が半透過反射膜を兼ねていることを特徴とする請求項３に記載の液晶表示装置。
【請求項６】液晶セルの両基板の内面にはそれぞれ液晶層に電界を印加するための電極が設けられており、これら電極はいずれも透明電極であって、裏面側基板の内面に設けられた電極の裏面側に、透明な絶縁膜を介して半透過反射膜が設けられていることを特徴とする請求項１に記載の液晶表示装置。
【請求項７】液晶セルは、裏面側基板の内面に複数の画素電極とこれら各画素電極にそれぞれ対応する複数の能動素子を配設し、表面側基板の内面に前記各画素電極と対向する対向電極を設けたアクティブマトリックス型セルであり、前記画素電極は透明電極であって、この画素電極の裏面側に、透明な絶縁膜を介して半透過反射膜が設けられていることを特徴とする請求項６に記載の液晶表示装置。
【請求項８】半透過反射膜の反射面はほぼ鏡面であることを特徴とする請求項１に記載の液晶表示装置。
【請求項９】液晶セルの表面側に配置された第１の偏光板の一面が光散乱面となっていることを特徴とする請求項１または請求項８に記載の液晶表示装置。

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【請求項１０】偏光板の表面が光散乱面であることを特徴とする請求項９に記載の液晶表示装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、反射型表示機能と透過型表示機能とを有する液晶表示装置に関するものである。
【０００２】
【従来の技術】液晶表示装置として、自然光や室内照明光等の外光を利用し表面側から入射する光を反射させて表示する反射型表示機能と、光源からの光を裏面側から入射させて表示する透過型表示機能とを有するものがある。
【０００３】上記反射型表示機能と透過型表示機能とを有する液晶表示装置は、従来、図１８に示すような構成となっている。この液晶表示装置は、液晶セル１をはさんでその表面側と裏面側とにそれぞれ偏光板５，６を配置するとともに、液晶セル１の裏面側に設けた偏光板６の裏面側に、入射光をある反射率と透過率で反射および透過させるハーフミラー７を配置したものであり、光源８は、前記ハーフミラー７の背後に設けられている。
【０００４】なお、上記液晶セル１は、透明な電極を設けるとともにその上に配向膜を形成した一対の透明基板２，３をそれぞれの電極形成面を互いに対向させて枠状のシール材４を介して接合し、この両基板２，３間に液晶を挟持させたものであり、液晶の分子は、それぞれの基板２，３上における配向方向を前記配向膜で規制されて所定の配向状態に配向されている。
【０００５】また、上記光源８は、一般に、上記ハーフミラー７の裏面ほぼ全体に対向する導光板９と、この導光板９の一端面に向けて配置された光源ランプ１０とからなっている。前記導光板９は、アクリル樹脂等からなる透明板の裏面全体にAl（アルミニウム）等の蒸着膜からなる反射膜９ａを形成したもので、光源ランプ１０からの照明光は、導光板９にその一端面から入射して導光板９内を導かれ、この導光板９の表面全体から液晶セル１に向かって出射する。
【０００６】上記液晶表示装置は、外光の光量が十分な明るい場所では外光を利用する反射型表示を行なうものであり、このときは、液晶表示装置にその表面側から入射する外光が、図１８に実線矢印で示したように、表面側の偏光板５の偏光作用により直線偏光となって液晶セル１０に入射する。
【０００７】一方、液晶セル１の液晶分子の配向状態は、両基板２，３の電極間に印加される電圧によって変化し、この液晶分子の配向状態に応じて液晶層の複屈折効果が変化するため、液晶セル１に入射した直線偏光は、液晶分子の配向状態に応じた偏光状態の光となって

液晶セル１を出射し、この光が裏面側の偏光板６に入射する。

【０００８】そして、この光は、裏面側偏光板６の検光作用により画像光となってハーフミラー７に入射し、その光のうちハーフミラー７で反射された光が、前記裏面側偏光板６と、液晶セル１と、表面側偏光板５とを通って液晶表示装置の表面側に出射する。

【０００９】また、上記液晶表示装置は、外光の光量が少ない暗い場所でも、光源８からの照明光を利用して表示を行なえるものであり、光源ランプ１０を点灯させると、光源８からの照明光がハーフミラー７に入射し、このハーフミラー７を透過した光が、図１８に破線矢印で示したように、裏面側偏光板６の偏光作用により直線偏光となって液晶セル１０に入射し、その液晶分子の配向状態に応じた偏光状態の光となって表面側偏光板６に入射して、この光が表面側偏光板５の検光作用により画像光となって液晶表示装置の表面側に出射する。

【００１０】

【発明が解決しようとする課題】しかし、上記従来の液晶表示装置は、外光を利用する反射型表示の際の光のロスが大きく、そのために、反射型表示での表示が暗いという問題をもっていた。これは、液晶表示装置にその表面側から入射した光が、表面側偏光板５と液晶セル１と裏面側偏光板６とを通ってハーフミラー７に入射し、このハーフミラー７で反射された光が、前記裏面側基板６と液晶セル１と表面側偏光板５とを通って液晶表示装置の表面側に出射するためであり、したがって、表面側から入射した光が、再び表面側に出射するまでの間に、表裏の偏光板５，６をそれぞれ２回ずつ計４回通るとともに、液晶セル１の両方の基板２，３もそれぞれ２回ずつ計４回通るから、偏光板５，６および液晶セル１の基板２，３での光吸収による光量ロスが大きくて、表示が暗くなってしまう。

【００１１】本発明は、外光を利用する反射型表示機能と光源からの光を利用する透過型表示機能とを有する液晶表示装置として、外光を利用する反射型表示の際の偏光板および液晶セルの基板での光吸収による光量ロスを少なくし、反射型表示での表示を十分明るくすることができるものを提供することを目的としたものである。

【００１２】

【課題を解決するための手段】本発明の液晶表示装置は、表裏一対の透明基板間に液晶を挟持させた液晶セルと、この液晶セルの表面側に配置された第１の偏光板と、前記液晶セルの裏面側に配置された第２の偏光板とからなり、かつ、前記液晶セルの裏面側基板の内面に、入射光をある反射率と透過率で反射および透過させる半透過反射膜が設けられていることを特徴とするものである。

【００１３】本発明の液晶表示装置において、前記液晶セルの両基板の内面にそれぞれ設けられている電極のうち、裏面側基板の内面に設けられている電極に前記半透過反射膜を兼ねさせてもよい。



【００１４】この場合、例えば前記液晶セルが、裏面側基板の内面に複数の画素電極とこれら各画素電極にそれぞれ対応する複数の能動素子を配設し、表面側基板の内面に前記各画素電極と対向する対向電極を設けたアクティブマトリックス型セルであるときは、前記画素電極に半透過反射膜を兼ねさせればよく、また、前記液晶セルが、表面側基板の内面に画素電極と能動素子を配設し、裏面側基板の内面に対向電極を設けたアクティブマトリックス型セルであるときは、前記対向電極に半透過反射膜を兼ねさせればよい。

【００１５】また、液晶セルが、裏面側基板の内面に画素電極と能動素子を配設したアクティブマトリックス型セルであって、前記画素電極に半透過反射膜を兼ねさせる場合は、前記能動素子を保護絶縁膜で覆い、半透過反射膜を兼ねる画素電極を前記保護絶縁膜の上に前記能動素子を覆って設けて、前記保護絶縁膜に形成したコンタクト孔において前記能動素子に接続してもよい。

【００１６】さらに、本発明の液晶表示装置において、前記液晶セルの両基板の内面にそれぞれ設けられている電極はいずれも透明電極であってもよく、その場合は、裏面側基板の内面に設けられた電極の裏面側に、透明な絶縁膜を介して半透過反射膜を設ければよい。

【００１７】この場合、例えば前記液晶セルが、裏面側基板の内面に画素電極と能動素子を配設したアクティブマトリックス型セルであるときは、前記画素電極を透明電極とし、この画素電極の裏面側に透明な絶縁膜を介して半透過反射膜を設ければよい。

【００１８】また、本発明の液晶表示装置において、前記半透過反射膜の反射面はほぼ鏡面であるのが望ましい。また、前記表面側偏光板は、その一面が光散乱面となっているものが望ましく、さらにこの偏光板は、その表面が光散乱面であるものがより望ましい。

【００１９】

【作用】本発明の液晶表示装置は、外光の光量が十分な明るい場所では外光を利用する反射型表示を行なうものであり、このときは、液晶表示装置にその表面側から入射する外光が、液晶セルの表面側に配置されている第１の偏光板の偏光作用により直線偏光となって液晶セルに入射するとともに、その液晶層を通った光が液晶セルの裏面側基板の内面に設けられている半透過反射膜に入射し、この半透過反射膜で反射された光が再び液晶層を通って前記第１の偏光板に入射して、この偏光板を透過する光が画像光となって液晶表示装置の表面側に出射する。

【００２０】また、この液晶表示装置は、外光の光量が少ない暗い場所でも、光源からの光を利用して表示を行なえるものであり、そのときは、光源からの光が、液晶セルの裏面側に配置されている第２の偏光板の偏光作用

により直線偏光となって液晶セルにその裏面側から入射し、前記半透過反射膜を透過した光が液晶層通って上記第１の偏光板に入射して、この偏光板を透過する光が画像光となって液晶表示装置の表面側に出射する。

【００２１】すなわち、本発明の液晶表示装置は、液晶セルの裏面側基板の内面に半透過反射膜を設けることにより、外光を利用する反射型表示時には、液晶セルの表面側に配置した第１の偏光板に入射光を直線偏光とする偏光作用と液晶セルの液晶層を通った光を画像光とする検光作用との両方の作用をもたせて、液晶セルの裏面側に配置した第２の偏光板は用いずに表示するものであり、この液晶表示装置によれば、外光を利用する反射型表示を、液晶セルの裏面側に配置した第２の偏光板および前記液晶セルの裏面側基板によって出射光量をロスすることなく行なえるため、外光を利用する反射型表示の際の偏光板および液晶セルの基板での光吸収による光量ロスを少なくし、反射型表示での表示を十分明るくすることができる。

【００２２】また、本発明の液晶表示装置において、前記液晶セルの両基板の内面にそれぞれ設けられている電極のうち、裏面側基板の内面に設けられている電極に前記半透過反射膜を兼ねさせれば、液晶セルの構造を簡素化するとともにその製造を容易にすることができる。

【００２３】すなわち、例えば前記液晶セルが、裏面側基板の内面に画素電極と能動素子を配設し、表面側基板の内面に対向電極を設けたアクティブマトリックス型セルであるときは、前記画素電極に半透過反射膜を兼ねさせ、また前記液晶セルが、表面側基板の内面に画素電極と能動素子を配設し、裏面側基板の内面に対向電極を設けたアクティブマトリックス型セルであるときは、前記対向電極に半透過反射膜を兼ねさせればよく、このようにすれば、液晶セルの構造を簡素化できるし、また前記画素電極あるいは対向電極と半透過反射膜とを同時に形成できるから、液晶セルの製造も容易になる。

【００２４】また、前記液晶セルが、裏面側基板の内面に画素電極と能動素子を配設したアクティブマトリックス型セルであって、前記画素電極に半透過反射膜を兼ねさせる場合、前記能動素子を保護絶縁膜で覆い、半透過反射膜を兼ねる画素電極を前記保護絶縁膜の上に前記能動素子を覆って設けて、前記保護絶縁膜に形成したコンタクト孔において前記能動素子に接続してもよく、このようにすれば、半透過反射膜を兼ねる画素電極の面積を大きくして、反射型表示の際の開口率を上げることができる。

【００２５】さらに、本発明の液晶表示装置において、前記液晶セルの両基板の内面にそれぞれ設けられている電極はいずれも透明電極であってもよく、その場合は、裏面側基板の内面に設けられた電極の裏面側に、透明な絶縁膜を介して半透過反射膜を設ければよいが、例えば前記液晶セルが、裏面側基板の内面に画素電極と能動素子を配設したアクティブマトリックス型セルである場合、前記画素電極を透明電極とし、この画素電極の裏面側に透明な絶縁膜を介して半透過反射膜を設ければ、この半透過反射膜と前記画素電極およびその間の絶縁膜とによって、非選択期間における画素の保持電圧を補償する補償容量を構成することができる。

【００２６】また、本発明の液晶表示装置においては、液晶セルの裏面側基板の内面に半透過反射膜を設けているため、この半透過反射膜を拡散反射膜とすることは難しいが、液晶セルの表面側に配置した第１の偏光板の一面が光散乱面となっていれば、前記半透過反射膜の反射面がほぼ鏡面であっても、表示観察者の顔やその背景等の外部像が前記反射面に写って見えることはない。

【００２７】さらに、本発明の液晶表示装置において、前記半透過反射膜の反射面がほぼ鏡面であれば、反射型表示において液晶セルの液晶層により偏光状態を変えられた光を半透過反射膜によって散乱させてしまうことはなく、また透過型表示においても、第２の偏光板を通って液晶セルにその裏面側から入射する光を半透過反射膜によって散乱させてしまうことはない。

【００２８】そして、この場合、前記第１の偏光板の表面が光散乱面であれば、反射型表示の際に液晶表示装置にその表面側から入射する光が散乱されてから第１の偏光板の偏光作用により直線偏光になるし、また反射型表示においても透過型表示においても、液晶セルの液晶層を通った光が前記第１の偏光板の検光作用により画像光となってから散乱されるため、入射光が前記第１の偏光板を通って画像光となるまでは光が散乱されることはなく、したがって、品質の良い画像を表示することができる。

【００２９】

【実施例】

［第１の実施例］図１～図１４は本発明の第１の実施例を示しており、図１は液晶表示装置の基本構成図、図２は前記液晶表示装置の一部分の拡大断面図である。

【００３０】この実施例の液晶表示装置は、複屈折屈折効果を利用してカラー画像を表示するもので、液晶セル１０の表面側（図において上側）に第１の偏光板（以下、表面側偏光板という）３１を配置し、前記液晶セル１０の裏面側（図において下側）に第２の偏光板（以下、裏面側偏光板という）３２を配置するとともに、前記液晶セル１０と前記表面側偏光板３１との間に位相差板４０を配置し、さらに前記裏面側偏光板３２の背後に光源５０を配置して構成されている。

【００３１】まず、上記液晶セル１０について説明すると、この液晶セル１０はアクティブマトリックス型セルであり、この実施例では、液晶２６の分子を両基板１１，１２間においてツイスト配向させたものを用いている。

【００３２】この液晶セル１０は、ガラス等からなる一

対の透明基板11，12間に液晶26を挟持させたものであり、一対の基板11，12のうち、裏面側の基板11の内面つまり液晶層との対向面には、複数の画素電極13とこれら各画素電極13にそれぞれ対応する複数の能動素子14とが行方向および列方向にマトリックス状に配設されており、その上に透明な配向膜22が設けられている。

【0033】上記能動素子14は、例えばTFT（薄膜トランジスタ）であり、このTFT14は、基板11上に形成されたゲート電極15と、このゲート電極15を覆うゲート絶縁膜16と、このゲート絶縁膜16の上に前記ゲート電極15と対向させて形成されたa－Si（アモルファスシリコン）等からなるi型半導体膜17と、このi型半導体膜17の両側部に不純物をドープしたa－Si 等からなるn型半導体膜18を介して形成されたソース電極19sおよびドレイン電極19dとからなっており、このTFT14は保護絶縁膜21で覆われている。

【0034】なお、20は、i型半導体膜17のチャンネル領域の上に形成されたブロッキング絶縁膜であり、このブロッキング絶縁膜20は、n型半導体膜18のパターニング時にi型半導体膜17を保護するために設けられたものである。

【0035】上記TFT14のゲート絶縁膜16は、SiN（窒化シリコン）等からなる透明絶縁膜であり、このゲート絶縁膜16は基板11のほぼ全面にわたって形成されている。

【0036】また、図示しないが、上記裏面側基板11の上には、上記TFT14のゲート電極15にゲート信号を供給するゲートライン（アドレスライン）と、前記TFT14のドレイン電極19dに画像データに応じたデータ信号を供給するデータラインとが配線されている。

【0037】上記ゲートラインは、基板11上に、上記TFT14のゲート電極15と一体に形成されており、このゲートラインは、その端子部を除いて前記ゲート絶縁膜16で覆われている。また、上記データラインは、前記ゲート絶縁膜16の上に形成されており、このデータラインは上記TFT14のドレイン電極19dにつながっている。

【0038】そして、上記画素電極13は、上記ゲート絶縁膜16の上に上記TFT14を避けて形成されており、各画素電極13はそれぞれ、その一端部において対応するTFT14のソース電極19sに接続されている。

【0039】また、上記画素電極13は、半透過反射膜Mを兼ねており、その反射面はほぼ鏡面となっている。この半透過反射膜Mは、市販のハーフミラーと同様に、入射光をある反射率と透過率で反射および透過させるものであり、この実施例では、画素電極13を、透過率が5～20%の半透過反射膜Mとしている。なお、反射率は約14%以上であればよい。

【0040】この半透過反射膜Mは、Al またはAl 系合金等の金属膜で形成されるか、あるいは、ITO膜等の透明導電膜と金属膜との積層膜とされている。図3および図4は半透過反射膜Mの第1の例を示すその一部分の断面図および平面図であり、この半透過反射膜Mは、スパッタ装置によって成膜した極く薄い金属薄膜13aからなっている。

【0041】すなわち、この半透過反射膜Mは、その下地面（ここではゲート絶縁膜16）の上に、スパッタ装置によって金属粒子を極く薄く堆積させて形成されたものであり、図に示した半透過反射膜Mは、金属粒子が堆積していない孔欠陥や、金属粒子の堆積厚さが薄い凹入欠陥等の微小な欠陥部kが点在する金属薄膜13aからなっている。なお、前記欠陥部kは不規則な形状であり、またその大きさおよび分布状態は金属薄膜13aの成膜厚さに応じて変化する。

【0042】この半透過反射膜Mは、図3に実線矢印で示した表面側からの入射光も、また破線矢印で示した裏面側からの入射光も、ある反射率と透過率で反射および透過させるものであり、上記金属薄膜13aの膜部分（欠陥部k以外の部分）に入射した光の一部は金属薄膜13aの膜面で反射され、またある量の光は金属薄膜13aを透過し、残りの光は金属薄膜13aに吸収される。

【0043】一方、上記金属薄膜13aの欠陥部kのうち、金属粒子の堆積厚さが薄い凹入欠陥部分は、金属膜厚が非常に薄いため、この凹入欠陥部分での反射および吸収量は極く僅かであり、したがって、この凹入欠陥部分に入射した光はその大部分が透過する。また、金属粒子が堆積していない孔欠陥部分に入射した光はその全てが透過光となる。

【0044】ただし、上記金属薄膜13aの単位面積当りの欠陥部kの総面積は、前記単位面積当りの膜部分の面積に比べて極く僅かであり、したがって、半透過反射膜Mの透過率は、金属薄膜13aの膜部分の透過率によってほとんど支配される。

【0045】そして、前記金属薄膜13aの膜部分の透過率は、その材料である金属の光学定数と膜厚とによって決まるため、この金属薄膜13a成膜厚さを選べば、上述した透過率が5～20%の半透過反射膜Mを得ることができる。

【0046】なお、図3および図4に示した半透過反射膜Mは、孔欠陥や凹入欠陥等の微小な欠陥部kが点在する金属薄膜13aからなるものであるが、この半透過反射膜Mは、前記孔欠陥や凹入欠陥等がほとんどない金属薄膜であってもよく、その場合でも、前記金属薄膜の厚さが約20nm以下であれば、この金属薄膜を半透過反射膜Mとして使用することができる。

【００４７】すなわち、スパッタ装置による金属薄膜の成膜においては、その成膜厚さが約１０ｎｍ以下であると、成膜された金属薄膜が孔欠陥や凹入欠陥のある膜となるが、成膜厚さを約１０ｎｍ以上に厚くしてゆくと、それにともなって前記孔欠陥や凹入欠陥の大きさが小さくなるとともにその分布数も少なくなり、ある程度以上の膜厚になると、孔欠陥や凹入欠陥がほとんど塞がって、表面がほぼ平坦な膜となる。

【００４８】その例をあげると、前記金属薄膜をAl またはAl －Ti （チタン）合金で形成する場合、例えば８．５ｎｍの厚さに成膜した金属薄膜は、図３および図４に示したような微小な欠陥部ｋのある膜であり、この金属薄膜の透過率は約１０～２０％、シート抵抗は５３Ωである。

【００４９】また、前記Al またはAl －Ti 合金を１７．０ｎｍの厚さに成膜した金属薄膜は、上記孔欠陥や凹入欠陥がほとんどない表面がほぼ平坦な膜であり、この金属薄膜の透過率は約５％以下、シート抵抗は１４Ωである。

【００５０】なお、上記半透過反射膜Mの透過率は、上述した５～２０％の範囲であればよいが、光源５０からの光をより有効に利用するためには、前記透過率を６％以上、さらに好ましくは７％以上にするのが望ましい。

【００５１】ただし、このように半透過反射膜Mの透過率を高くするには、前記金属薄膜の膜厚をある程度薄くしなければならないため、そのシート抵抗が高くなってしまうが、前記半透過反射膜Mを、ＩＴＯ膜等の透明導電膜と高反射率金属膜との積層膜とすれば、前記シート抵抗を低くすることができる。

【００５２】すなわち、図５および図６はそれぞれ半透過反射膜Mの第２および第３の例を示すその一部分の断面図であり、図５に示した半透過反射膜Mは、その下地面（ゲート絶縁膜１６）の上にＩＴＯ膜１３ｂをスパッタ装置により成膜し、その上に、図３および図４に示した金属薄膜１３ａを成膜したものである。

【００５３】また、図６に示した半透過反射膜Mは、その下地面（ゲート絶縁膜１６）の上に図３および図４に示した金属薄膜１３ａを成膜し、その上に、ＩＴＯ膜１３ｂをスパッタ装置により成膜したものである。

【００５４】これら図５および図６に示した半透過反射膜MのＩＴＯ膜１３ｂのシート抵抗は、このＩＴＯ膜１３ｂの膜厚を５０ｎｍとした場合で４０Ωであり、したがって、前記金属薄膜１３ａのシート抵抗がある程度高くても、半透過反射膜Mの見掛上のシート抵抗を低くすることができる。

【００５５】なお、図５および図６に示した半透過反射膜Mの金属薄膜１３ａは、孔欠陥や凹入欠陥等の微小な欠陥部ｋが点在する金属薄膜であるが、この金属薄膜は、前記欠陥部ｋがほとんどない表面がほぼ平坦な金属薄膜であってもよい。



【００５６】さらに、図７および図８は、半透過反射膜Mの第４の例を示すその一部分の断面図および平面図であり、この半透過反射膜Mは、微小な開口ｍを点在させて設けた光不透過金属膜１３ｃからなっている。

【００５７】すなわち、この半透過反射膜Mは、その下地面（ゲート絶縁膜１６）の上に、スパッタ装置によって、Al またはAl 系合金等からなる金属膜１３ｃを光を透過させない厚さ（３００ｎｍ程度）に成膜し、この金属膜１３ｃにフォトリソグラフィ法によって多数の微小開口ｍを設けたものである。

【００５８】この半透過反射膜Mは、前記金属膜１３ｃの膜部分（開口ｍ以外の部分）に入射した光を金属面で反射させ、開口ｍ部分に入射した光を透過させるものであり、図７に実線矢印で示した表面側からの入射光も、また破線矢印で示した裏面側からの入射光も、ある反射率と透過率で反射および透過される。

【００５９】この半透過反射膜Mは、光を透過させない厚さに成膜した比較的厚い金属膜１３ｃからなっているため、シート抵抗が低いという利点をもっている。また、この半透過反射膜Mの透過率は、上記金属膜１３ｃの単位面積内に分布する開口ｍの総面積によって決まる。

【００６０】ただし、この半透過反射膜Mにおいては、１つ１つの開口ｍの面積が大きいと、表面側から光を入射させてその反射光を観察したときに開口ｍ部分が黒点となって見え、裏面側から光を入射させてその透過光を観察したときに前記開口ｍ部分が輝点となって見えるため、このような黒点や輝点を目立たなくするには、１つ１つの開口ｍの幅を約３μｍ以下にし、その数によって所望の透過率を得るのが望ましい。

【００６１】そして、上記画素電極１３は、上述した第１～第４の例のいずれかの半透過反射膜Mをゲート絶縁膜１６の上に形成し、この半透過反射膜Mをフォトリソグラフィ法によりパターニングして形成されている。なお、図６および図７に示した半透過反射膜Mで画素電極を形成する場合は、その金属膜１３ｃへの開口ｍの形成と画素電極１３へのパターニングとを同時に行なうことができる。

【００６２】一方、液晶セル１０の表面側基板１２の内面つまり液晶層との対向面には、ＩＴＯ膜等からなる透明な対向電極２３が設けられ、その上に透明な配向膜２４が設けられている。なお、前記対向電極２３は、上記裏面側基板１１の各画素電極の全てに対向する一枚膜状の電極とされている。

【００６３】そして、上記裏面側基板１１と表面側基板１２とは、その外周縁部において枠状のシール材２５（図１参照）を介して接合されており、液晶２６は両基板１１，１２間の前記シール材２５で囲まれた領域に充填されている。

【００６４】この液晶２６は、誘電異方性が正のネマテ

ィック液晶であり、この液晶２６の分子は、両基板１１，１２に設けた配向膜２２，２４によってそれぞれの基板１１，１２上での配向方向を規制され、両基板１１，１２間においてツイスト配向されている。なお、上記配向膜２２，２４は、ポリイミド等からなる水平配向膜であり、その膜面にはラビングによる配向処理が施されている。

【００６５】また、上記表裏の偏光板３１，３２のうち、裏面側偏光板３２は通常の偏光板、表面側偏光板３１は、その一面、例えば表面が光散乱面Ａとなっている偏光板であり、この表面側偏光板３１の光散乱面Ａは、図９にその一部の断面を拡大して示したように、偏光板３１の表面に微小な凹凸をもつ透明膜３３を形成して構成されている。

【００６６】上記透明膜３３は、アクリル樹脂等の光透過率の高い樹脂からなっており、この透明膜３３は、樹脂材料を微小な凹凸をもつ印刷版を用いて偏光板３１面に転写印刷して硬化させる方法、前記樹脂材料を偏光板３１面に均一厚さに塗布して型押しにより凹凸を付けた後に硬化させる方法、あるいは、前記樹脂材料にシリカ等からなる透明な微粒子を混入したものを偏光板３１面に塗布して硬化させる方法のいずれかによって形成されている。

【００６７】この透明膜３３の凹凸の平均高さ（凹面と凸面との高さの差）ｈは１～５μｍ、凹凸の平均ピッチｐは５～４０μｍであり、上記光散乱面Ａのヘイズ値は、９～１４％である。

【００６８】なお、上記ヘイズ値は、ＪＩＳ Ｋ ６７１４に準ずる積分球式光線透過率測定装置（ヘイズメータ）による測定値である。このヘイズ値は次式により算出される。

【００６９】全光線透過率；Ｔｔ(%)＝Ｔ2 ／Ｔ1

平行光線透過率；Ｔｐ(%)＝Ｔｔ －Ｔｄ

拡散透過率；Ｔｄ(%)＝［Ｔ4 －Ｔ3 ×（Ｔ2 ／Ｔ1 ）］／Ｔ1

ヘイズ値；Ｈ(%) ＝（Ｔｄ ／Ｔｔ ）×１００

Ｔ1 ；入射光線量

Ｔ2 ；全光線透過光量

Ｔ3 ；測定装置の拡散光量

Ｔ4 ；試験片（透明膜３１）と測定装置による拡散光量

また、上記位相差板４０は、ポリカーボネート等の一軸延伸フィルムからなっており、この位相差板４０は、上記液晶セル１０の表面側に配置された表面側偏光板３１と前記液晶セル１０との間に、位相差板４０の遅相軸（延伸軸）と表面側偏光板３１の透過軸とを所定角度斜めにずらした状態で配置されている。

【００７０】なお、前記位相差板４０は液晶セル１０の表面（表面側基板１２の外面）に接着され、表面側偏光板３０は前記位相差板４０の表面に接着されており、また裏面側偏光板３２は液晶セル１０の裏面（裏面側基板１１の外面）に接着されている。

【００７１】また、上記光源５０は、従来の液晶表示装置に用いられている光源と同様なものであり、上記裏面側偏光板３２の裏面ほぼ全体に対向する導光板５１と、この導光板５１の一端面に向けて配置された白色光を発する光源ランプ５２とからなっている。

【００７２】前記導光板５１は、アクリル樹脂等からなる透明板の裏面全体にＡl 等の蒸着膜からなる反射膜５１ａを形成したもので、光源ランプ５２からの照明光は、導光板５１にその一端面から入射して導光板５１内を導かれ、この導光板５１の表面全体から液晶セル１０に向かって出射する。

【００７３】そして、この実施例の液晶表示装置では、上記表面側偏光板３１を、その透過軸を液晶セル１０の表面側基板１２上における液晶分子の配向方向（配向膜２４のラビング方向）に対して所定角度斜めにずらして配置するとともに、上記位相差板４０をその遅相軸（延伸軸）を前記表面側偏光板３１の透過軸に対して所定角度斜めにずらして配置し、さらに裏面側偏光板３２を、その透過軸を液晶セル１０の裏面側基板１１上における液晶分子の配向方向（配向膜２２のラビング方向）に対して所定角度斜めにずらして配置している。

【００７４】なお、この実施例では、液晶セル１０の裏面側基板１１上における液晶分子配向方向を方位角０°の方向とし、この方向を基準として、液晶セル１０の表面側基板１２上における液晶分子配向方向と偏光板３１，３２の透過軸方向および位相差板４０の遅相軸方向を設定している。

【００７５】すなわち、図１０は、上記液晶表示装置における液晶セル１０の液晶分子配向方向と、位相差板４０の遅相軸と、偏光板３１，３２の透過軸とを示す平面図であり、図において１１ａは液晶セル１０の裏面側基板１１上における液晶分子の配向方向、１２ａは液晶セル１０の表面側基板１２上における液晶分子の配向方向を示している。

【００７６】この図１０のように、液晶セル１０の表面側基板１２上における液晶分子配向方向１２ａは、裏面側基板１１上における液晶分子配向方向１１ａ方向、つまり方位角０°の方向に対し、表面側から見て左回りにほぼ９０°ずれており、液晶２６の分子は両基板１１，１２間においてほぼ９０°のツイスト角でツイスト配向されている。

【００７７】また、図１０において、３１ａは表面側偏光板３１の透過軸、４０ａは位相差板４０の遅相軸を示しており、表面側偏光板３１の透過軸３１ａは上記方位角０°の方向に対し表面側から見て左回りにほぼ１７０°の方向、位相差板４０の遅相軸４０ａは方位角０°の方向に対し表面側から見て左回りにほぼ１５０°の方向にあり、したがって、位相差板４０の遅相軸４０ａは、表面側偏光板３１の透過軸３１ａに対し、表面側から見

て右回りにほぼ２０°斜めにずれている。

【００７８】さらに、図１０において、３２ａは裏面側偏光板３２の透過軸を示しており、この裏面側偏光板３２の透過軸３２ａは上記方位角０°の方向に対し表面側から見て左回りにほぼ１５０°の方向にある。

【００７９】この液晶表示装置は、外光（自然光または室内照明光等）の光量が十分な明るい場所では前記外光を利用する反射型表示を行なうものであり、このときは、液晶表示装置にその表面側から入射する外光が、図１に実線矢印で示したように、表面側偏光板３１の偏光作用により直線偏光となって液晶セル１０に入射するとともに、その液晶層を通った光が液晶セル１０の裏面側基板１１の内面に設けられている半透過反射膜Ｍ（画素電極１３）に入射し、この半透過反射膜Ｍで反射された光が再び液晶層を通って前記表面側偏光板３１に入射して、この偏光板３１を透過する光が画像光となって液晶表示装置の表面側に出射する。

【００８０】また、この液晶表示装置は、外光の光量が少ない暗い場所でも、光源５０からの光を利用して表示を行なえるものであり、そのときは、光源５０からの光が、図１に破線矢印で示したように、裏面側偏光板３２の偏光作用により直線偏光となって液晶セル１０に入射し、その裏面側基板１１の内面に設けられている半透過反射膜Ｍ（画素電極１３）を透過した光が液晶層を通って上記表面側偏光板３１に入射して、この偏光板３１を透過する光が画像光となって液晶表示装置の表面側に出射する。

【００８１】すなわち、上記液晶表示装置は、液晶セル１０の裏面側基板１１の内面に半透過反射膜Ｍを設けることにより、外光を利用する反射型表示時には、液晶セル１０の表面側に配置した表面側偏光板３１に入射光を直線偏光とする偏光作用と液晶セル１０の液晶層を通った光を画像光とする検光作用との両方の作用をもたせて、液晶セル１０の裏面側に配置した裏面側偏光板３２は用いずに表示し、光源５０からの光を利用する透過型表示の際は、前記裏面側偏光板３２を偏光子とし、前記表面側偏光板３１を検光子として表示するものである。

【００８２】上記液晶表示装置の表示動作を、まず外光を利用する反射型表示について説明すると、この液晶表示装置においては、表面側偏光板３１の透過軸３１ａに対して位相差板４０の遅相軸４０ａが斜めにずれているため、前記表面側偏光板３１を通って入射した直線偏光が、位相差板４０を通る過程でその複屈折効果により波長ごとに偏光状態が異なる楕円偏光となり、この楕円偏光が、液晶セル１０の液晶層を通る過程でその複屈折効果によりさらに偏光状態を変えられて液晶セル１０の裏面側基板１１の内面に設けた半透過反射膜Ｍに入射するとともに、その光のうち前記半透過反射膜Ｍで反射された光が、再び液晶層および位相差板４０を通る過程でこれらの複屈折効果によりさらに偏光状態を変えられて前記表面側偏光板３１に入射する。

【００８３】そして、この表面側偏光板３１に入射する反射光は、上記位相差板４０と液晶セル１０の液晶層の複屈折効果により偏光状態を変えられた非直線偏光であるため、その光のうち、表面側偏光板３１を透過する偏光成分の波長光だけがこの偏光板３１を透過して出射し、この出射光中の各波長光の比率に対応した着色光となる。

【００８４】次に、光源５０からの光を利用するときの表示について説明すると、このときは、光源５０からの光が裏面側偏光板３２を通って直線偏光となり、この直線偏光が液晶セル１０にその裏面側から入射して、そのうち液晶セル１０の裏面側基板１１の内面に設けられている半透過反射膜Ｍを透過した光が液晶層を通るが、上記液晶表示装置においては、前記裏面側偏光板３２の透過軸３２ａが液晶セル１０の裏面側基板１１上における液晶分子の配向方向１１ａに対して斜めにずれているため、液晶セル１０にその裏面側から入射した直線偏光が、この液晶セル１０の液晶層を通る過程でその複屈折効果により波長ごとに偏光状態が異なる楕円偏光となり、この楕円偏光が、位相差板４０を通る過程でその複屈折効果によりさらに偏光状態を変えられて表面側偏光板３１に入射する。

【００８５】そして、このときも、表面側偏光板３１に入射する光は、液晶セル１０の液晶層と位相差板４０の複屈折効果により偏光状態を変えられた非直線偏光であるため、その光のうち、表面側偏光板３１を透過する偏光成分の波長光だけがこの偏光板３１を透過して出射し、この出射光中の各波長光の比率に対応した着色光となる。

【００８６】つまり、上記液晶表示装置は、外光を利用する反射型表示においては、位相差板４０および液晶セル１０の液晶層の複屈折効果と表面側偏光板３１の偏光および検光作用とを利用して光を着色し、光源５０からの光を利用する透過型表示においては、液晶セル１０の液晶層および位相差板４０の複屈折効果と裏面側偏光板３２の偏光作用および表面側偏光板３１の検光作用とを利用して光を着色するものであり、この液晶表示装置によれば、一般に用いられているカラーフィルタを用いた液晶表示装置に比べて、非常に明るい着色光を得ることができる。

【００８７】すなわち、カラーフィルタは、その色に対応する波長域以外の波長光を吸収して光を着色するが、このカラーフィルタは、その色に対応する波長域の光もかなり高い吸収率で吸収するため、カラーフィルタによって光を着色する液晶表示装置では、表示装置に入射する光のうちの着色光となる波長帯域の光量に比べて、カラーフィルタを通った着色光の光量がかなり減少する。

【００８８】この点、上記実施例の液晶表示装置は、カラーフィルタを用いずに光を着色するものであるため、

カラーフィルタによる光吸収はないし、また、位相差板４０と液晶セル１０の液晶２７は、透過光の偏光状態を変えるだけでほとんど光を吸収しない。
【００８９】このため、これらの複屈折効果により偏光状態を変えられ、表面側偏光板３１を透過して出射する着色光の光量は、反射型表示の際の表面側偏光板３１を通って入射して上記半透過反射膜Ｍで反射された光のうちの前記着色光となる波長帯域の光の量、あるいは、反射型表示の際の裏面側偏光板３２を通って入射して前記半透過反射膜Ｍを透過した光のうちの前記着色光となる波長帯域の光の量とほとんど変わらず、したがって、高輝度の着色光が得られる。
【００９０】また、カラーフィルタによって光を着色する液晶表示装置では、その表示色がカラーフィルタの色によって決まるため、１つの画素で複数の色を表示することはできなかったが、上記実施例の液晶表示装置によれば、１つの画素で複数の色を表示することができる。
【００９１】すなわち、上記実施例の液晶表示装置においては、位相差板４０の複屈折効果は変化しないが、液晶セル１０の液晶層の複屈折効果は、両基板１１，１２の電極１３，２３間に印加される電圧によって液晶分子の配向状態が変化するのにともなって変化するため、液晶セル１０への印加電圧を制御して、位相差板４０と液晶セル１０の液晶層とを通った光の偏光状態を変化させてやれば、表面側偏光板３１を透過して出射する着色光の色を変化させることができ、したがって、１つの画素で複数の色を表示することができる。
【００９２】なお、この液晶表示装置の表示駆動は、基本的には、一般に知られているアクティブマトリックス型液晶表示装置（ＴＦＴを能動素子とするもの）の表示駆動と同様に、液晶セル１０の対向電極２３に同期信号に同期した波形の基準信号を供給し、各ゲートラインに前記同期信号に同期させて順次ゲート信号を供給するとともに、それに同期させて各データラインに画像データに応じた電位のデータ信号を供給することによって行なえばよく、前記データ信号の電位を画像データに応じて制御すれば、各行の画素の選択期間に前記画像データに応じた電位のデータ信号がＴＦＴ１４を介して画素電極１３に供給され、このデータ信号に応じた電圧が画素電極１３と対向電極２３との間に印加される。
【００９３】上記液晶表示装置の表示色について説明すると、例えば上述したように、液晶セル１０が液晶分子を両基板１１，１２間においてほぼ９０°のツイスト角でツイスト配向させたものであって、その両基板１１，１２上における液晶分子の配向方向１１ａ，１２ａと、偏光板３１，３２の透過軸３１ａ，３２ａと、位相差板４０の遅相軸４０ａとがそれぞれ図１０に示した方向にあり、かつ、液晶セル１０のΔｎ・ｄ（液晶２６の屈折率異方性Δｎと液晶層厚ｄとの積）の値が約９８０ｎｍ（例えば、Δｎ＝０．２０４，ｄ＝４．８$\mu$ｍ）、位相


差板４０のリタデーションの値が約３７０ｎｍである場合、外光を利用する反射型表示では、各画素の表示色が液晶セル１０への印加電圧に応じて赤、青、緑、黒、白に変化し、また光源５０からの光を利用する透過型表示では、各画素の表示色が液晶セル１０への印加電圧に応じて赤，緑，青，白に変化する。
【００９４】図１１および図１２は、上記液晶表示装置の反射型表示における表示色の変化を示しており、図１１は印加電圧に対する出射光の色変化を示すＣＩＥ色度図、図１２は電圧－出射率特性図である。なお、ここでは、液晶表示装置にその法線に対して３０°の方向（方位は任意でよい）から白色光を入射させ、液晶表示装置の法線方向から出射光を観察した結果を示している。
【００９５】この反射型表示においては、液晶セル１０の電極１３，２３間に印加する電圧値を大きくしてゆくのにともなって、出射光の色が図１１に示すように矢印方向に変化してゆき、その途中で出射光が、図１２に示すように、光強度が高くかつ色純度もよい、赤、青、緑、黒、白の色になる。なお、この場合の赤の出射光は、紫色を帯びた赤色光である。
【００９６】このように、上記液晶表示装置は、外光を利用する反射型表示の場合で１つの画素で前記赤、青、緑、黒、白の色を表示することができるし、また隣接する複数の画素に異なる色を表示させることにより、前記赤、青、緑、黒、白のうちの複数の色による混色を表示させることもできる。
【００９７】また、図１３および図１４は、上記液晶表示装置の透過型表示における表示色の変化を示しており、図１３は印加電圧に対する出射光の色変化を示すＣＩＥ色度図、図１４は電圧－出射率特性図である。なお、この図１３および図１４も、液晶表示装置にその法線に対して３０°の方向（方位は任意でよい）から白色光を入射させ、液晶表示装置の法線方向から出射光を観察した結果を示している。
【００９８】この反射型表示においては、液晶セル１０の電極１３，２３間に印加する電圧値を大きくしてゆくのにともなって、出射光の色が図１３に示すように矢印方向に変化してゆき、その途中で出射光が、図１４に示すように、光強度が高くかつ色純度もよい、赤、緑、青、白の色になる。
【００９９】このように、上記液晶表示装置は、光源５０からの光を利用する反射型表示でも、１つの画素で前記赤、緑、青、白の色を表示することができるし、また隣接する複数の画素に異なる色を表示させることにより、前記赤、緑、青、白のうちの複数の色による混色を表示させることもできる。
【０１００】なお、この反射型表示における印加電圧に対応した表示色および色数は上記透過型表示の場合とは異なるため、反射型表示の際にも透過型表示の場合と同様に液晶セル１０を駆動すると、透過型表示の場合とは

異なる色のカラー画像が表示されるが、反射型表示の際に液晶セル１０の駆動条件（画像データに対応するデータ信号の電位等）を制御すれば、反射型表示においても、透過型表示に近い色のカラー画像を表示することができる。

【０１０１】ただし、上記液晶表示装置は、ほとんどの場合は外光を利用する反射型表示装置として使用され、外光の光量が少ない暗い場所で一時的に表示情報を見たいときに光源５０を点灯させて反射型表示装置として使用されるため、反射型表示における表示画像の色の違いはあまり問題にはならないから、液晶セル１０の駆動条件を透過型表示を基準として設計し、反射型表示も透過型表示と同じ駆動条件で液晶セル１０の駆動して行なってもよい。

【０１０２】また、上記実施例の液晶表示装置は、反射型表示において赤、青、緑、黒、白の色を表示し、透過型表示において赤、緑、青、白の色を表示するものであるが、この液晶表示装置の表示色は、印加電圧と、液晶セル１０の両基板１１，１２上における液晶分子の配向方向１１ａ，１２ａおよび液晶分子のツイスト角と、偏光板３１，３２の透過軸３１ａ，３２ａの方向および位相差板４０の遅相軸４０ａの方向とによって決まるから、これらの条件を選択すれば、前記表示色を任意に選ぶことができる。

【０１０３】そして、上記液晶表示装置は、液晶セル１０の裏面側基板１１の内面に半透過反射膜Ｍを設けることにより、外光を利用する反射型表示時には、表面側偏光板３１に入射光を直線偏光とする偏光作用と液晶セル１０の液晶層を通った光を画像光とする検光作用との両方の作用をもたせて、裏面側偏光板３２は用いずに表示するものであるため、前記反射型表示を、裏面側偏光板３２および液晶セル１０の裏面側基板１１によって出射光量をロスすることなく行なえるため、外光を利用する反射型表示の際の偏光板および液晶セルの基板での光吸収による光量ロスを少なくし、反射型表示での表示を十分明るくすることができる。

【０１０４】なお、上記液晶表示装置においては、光が、位相差板４０と液晶セル１０の液晶層も通るが、この位相差板４０と液晶層は前述したようにほとんど光を吸収しないため、これらによる光量ロスはほとんどない。

【０１０５】また、上記液晶表示装置においては、液晶セル１０の裏面側基板１１の内面に半透過反射膜Ｍを設けているため、この半透過反射膜Ｍを拡散反射膜とすることは難しいが、上述したように、液晶セル１０の表面側に配置した表面側偏光板３１の一面が光散乱面Ａとなっていれば、液晶表示装置への入射光および出射光を前記光散乱面Ａで散乱させることができるため、前記半透過反射膜Ｍの反射面がほぼ鏡面であっても、表示観察者の顔やその背景等の外部像が前記反射面に写って見える



ことはない。

【０１０６】さらに、上記液晶表示装置において、半透過反射膜Ｍを兼ねる画素電極１３の表面がほぼ鏡面であれば、反射型表示において液晶セル１０の液晶層により偏光状態を変えられた光を半透過反射膜Ｍによって散乱させてしまうことはなく、また透過型表示においても、裏面側偏光板３２を通って液晶セル１０にその裏面側から入射する光を半透過反射膜Ｍによって散乱させてしまうことはない。

【０１０７】そして、この場合、前記表面側偏光板３１の表面が光散乱面Ａであれば、反射型表示の際に液晶表示装置にその表面側から入射する光が散乱されてから表面側偏光板３１の偏光作用により直線偏光になるし、また反射型表示においても透過型表示においても、液晶セル１０の液晶層を通った光が前記表面側偏光板３１の検光作用により画像光となってから散乱されるため、入射光が前記表面側偏光板３１を通って画像光となるまでは光が散乱されることはなく、したがって、品質の良い画像を表示することができる。

【０１０８】なお、上記光散乱面Ａの散乱効果は、上述したヘイズ値によって決まり、このヘイズ値が２５％以上であると、表面側偏光板３１の検光作用によって画像光となった光も大きく散乱されて表示画像が不鮮明になり、またヘイズ値が６％以下であると上記外部像の写り込みを生じるが、光散乱面Ａのヘイズ値が９～１４％の範囲であれば、鮮明な表示画像を得るとともに外部像の写り込みもなくすことができる。

【０１０９】しかも、上記液晶表示装置では、液晶セル１０の裏面側基板１１の内面に設けた画素電極１３に半透過反射膜Ｍを兼ねさせているため、液晶セル１０の裏面側基板１１の内面に半透過反射膜を設けたものでありながら、液晶セル１０の構造を簡素化できるし、また前記画素電極１３と半透過反射膜Ｍとを同時に形成できるから、液晶セル１０の製造も容易になる。

【０１１０】［第２の実施例］なお、上記第１の実施例では、半透過反射膜Ｍを兼ねる画素電極１３を、ＴＦＴ１４を避けて形成しているが、この画素電極１３は前記ＴＦＴ１４を覆って形成してもよい。

【０１１１】図１５は本発明の第２の実施例を示す液晶表示装置の一部分の断面図であり、この実施例の液晶表示装置は、液晶セル１０の裏面側基板１１の内面に配設したＴＦＴ１４を覆う保護絶縁膜２１をＳｉ Ｎ膜等の透明絶縁膜とし、この保護絶縁膜２１を前記裏面側基板１１のほぼ全面にわたって形成して、この保護絶縁膜２１の上に、半透過反射膜Ｍを兼ねる画素電極１３をその一部で前記ＴＦＴ１４を覆って形成し、この画素電極１３を、前記保護絶縁膜２１に形成したコンタクト孔２１ａにおいてＴＦＴ１４のソース電極１９ｓに接続したものである。

【０１１２】なお、この実施例は、ＴＦＴ１４を覆う保

護絶縁膜２１と画素電極１３の形成状態が異なるだけで、他の構成は上述した第１の実施例と同じであるから、重複する説明は図に同符号を付して省略する。

【０１１３】この実施例のように、ＴＦＴ１４を保護絶縁膜２１で覆い、その上に画素電極１３を前記ＴＦＴ１４を覆って設ければ、半透過反射膜Ｍを兼ねる画素電極１３の面積を大きくすることができ、したがって、上述した第１の実施例の効果に加えて、外光を利用する反射型表示の際の開口率を上げることができる。

【０１１４】なお、この実施例の液晶表示装置においても、光源５０からの光を利用する透過型表示の際は透過光がＴＦＴ１４部分で遮られるため、透過型表示のときの開口率は上述した第１の実施例とほぼ同じであるが、上記液晶表示装置は上述したように、ほとんどの場合は外光を利用する反射型表示装置として使用されるため、反射型表示の際の開口率を上げることができる効果は大きい。

【０１１５】［第３の実施例］また、上記第１および第２の実施例では、液晶セル１０の裏面側基板１１に画素電極１３とＴＦＴ１４を設けているが、前記液晶セル１０は、画素電極１３とＴＦＴ１４を表面側基板１２に設けたものでもよい。

【０１１６】図１６は本発明の第３の実施例を示す液晶表示装置の一部分の断面図であり、この実施例は、液晶セル１０を、表面側基板１２の内面に複数の画素電極１３とこれら各画素電極１３にそれぞれ対応する複数のＴＦＴ１４を配設し、裏面側基板１１の内面に前記各画素電極１３と対向する対向電極２３を設けたアクティブマトリックス型セルとしたものであって、前記画素電極１３はＩＴＯ膜等からなる透明電極とされ、前記対向電極２３は、図３および図４、図５、図６、図７および図８に示した半透過反射膜Ｍのいずれかで形成されている。

【０１１７】なお、この実施例の液晶表示装置は、液晶セル１０の表面側基板１２の内面に透明な画素電極１３とＴＦＴ１４を設け、裏面側基板１１の内面に半透過反射膜Ｍを兼ねる対向電極２３を設けたものであって、前記ＴＦＴ１４の構成は上述した第１の実施例のものと同じであるし、また、偏光板３１，３２および位相差板４０の配置も前記第１の実施例と同じであるから、重複する説明は図に同符号を付して省略する。

【０１１８】この実施例の液晶表示装置においても、上述した第１の実施例と同様に、カラーフィルタを用いずに表示を着色して明るいカラー表示を得、しかも１つの画素で複数の色を表示することができるるとともに、外光を利用する反射型表示の際の偏光板および液晶セルの基板での光吸収による光量ロスを少なくして、反射型表示での表示を十分明るくすることができるし、また、液晶セル１０の裏面側基板１１に設けた対向電極２３に半透過反射膜Ｍを兼ねさせているため、液晶セルの構造を簡素化するとともにその製造を容易にすることができる。

【０１１９】［第４の実施例］また、上記第１～第３の実施例では、液晶セル１０の裏面側基板１１の内面に設けた電極（第１および第２の実施例では画素電極１３、第３の実施例では対向電極２３）に半透過反射膜Ｍを兼ねさせているが、前記裏面側基板１１の内面に設けた電極もＩＴＯ膜等からなる透明電極とし、この電極の裏面側に透明な絶縁膜を介して半透過反射膜を設けてもよい。

【０１２０】図１７は本発明の第４の実施例を示す液晶表示装置の一部分の断面図であり、この実施例は、液晶セル１０を、裏面側基板１１の内面に画素電極１３とＴＦＴ１４を配設し、表面側基板１２の内面に対向電極２３を設けたアクティブマトリックス型セルとするとともに、前記画素電極１３および対向電極２３はＩＴＯ膜等からなる透明電極とし、裏面側基板１１の内面に設けた前記画素電極１３の裏面側に、ＴＦＴ１４のゲート絶縁膜（透明膜）１６を介して半透過反射膜（図３および図４、図５、図６、図７および図８に示した半透過反射膜のいずれか）Ｍを設けたものである。

【０１２１】なお、この実施例の液晶表示装置は、液晶セル１０の裏面側基板１１の内面に設けた画素電極１３を透明電極とし、その裏面側に半透過反射膜Ｍを設けた点を除けば、その他の構成は上述した第１の実施例を同じであるから、重複する説明は図に同符号を付して省略する。

【０１２２】この実施例の液晶表示装置においても、上述した第１の実施例と同様に、カラーフィルタを用いずに表示を着色して明るいカラー表示を得、しかも１つの画素で複数の色を表示することができるるとともに、外光を利用する反射型表示の際の偏光板および液晶セルの基板での光吸収による光量ロスを少なくして、反射型表示での表示を十分明るくすることができる。

【０１２３】また、この実施例では、液晶セル１０の裏面側基板１１の内面に設けた画素電極１３を透明電極とし、この画素電極１３の裏面側に透明なゲート絶縁膜１６を介して半透過反射膜Ｍを設けているため、この半透過反射膜Ｍと前記画素電極１３およびその間のゲート絶縁膜とによって、非選択期間における画素の保持電圧を補償する補償容量Ｃs を構成することができる。

【０１２４】なお、このように前記半透過反射膜Ｍを利用して画素の補償容量Ｃs を構成する場合は、前記裏面側基板１１の上に基準電位接続ラインを配線（図示しないが、例えば半透過反射膜Ｍと一体に形成する）し、半透過反射膜Ｍを前記基準電位接続ラインを介して基準電位に接続する。

【０１２５】［他の実施例］なお、上述した第１～第４の実施例の液晶表示装置は、いずれも、液晶セル１０として、液晶分子をほぼ９０°のツイスト角でツイスト配向させたものを用いるものであるが、この液晶分子のツ

イスト角は、９０°に限らず、例えば１８０～２７０°としてもよいし、さらに、前記液晶セル１０は、液晶分子をホモジニアス配向、ホメオトロピック配向、ハイブリッド配向等の配向状態に配向させたものでもよい。

【０１２６】また、上記各実施例の液晶表示装置は、位相差板４０および液晶セル１０の液晶層の複屈折効果と偏光板３１，３２の偏光および検光作用とを利用して光を着色するものであるが、本発明は、前記位相差板４０を備えず、液晶セル１０の液晶層の複屈折効果と偏光板３１，３２の偏光および検光作用とを利用して光を着色する複屈折効果型のカラー液晶表示装置にも適用できるものであり、その場合も、表面側偏光板３１の透過軸３１ａを液晶セル１０の表面側基板１２上における液晶分子配向方向１２ａに対して斜めにずらし、裏面側偏光板３２の透過軸３２ａを液晶セル１０の裏面側基板１１上における液晶分子配向方向１１ａに対して斜めにずらせば、液晶セル１０の液晶層の複屈折効果と偏光板３１，３２の偏光および検光作用とを利用して光を着色することができる。

【０１２７】ただし、上記実施例のように、液晶セル１０と表面側偏光板３１との間に位相差板４０を配置すれば、液晶セル１０に液晶分子が基板１１，１２面に対してほぼ垂直に立上がり配向する電圧を印加したとき、つまり液晶層の複屈折効果が見掛上ほとんどなくなったときでも、位相差板４０の複屈折効果によって着色光を得ることができる。この場合、位相差板は２枚以上重ねて配置してもよい。

【０１２８】さらに、上記各実施例では、液晶セル１０としてアクティブマトリックス型セルを用いたが、この液晶セル１０は、単純マトリックス型セルやセグメント表示型セル等であってもよい。

【０１２９】また、上記実施例の液晶表示装置は、複屈折効果を利用してカラー画像を表示するものであるが、本発明は、ＴＮ型やＳＴＮ型の液晶表示装置にも適用することができる。

【０１３０】

【発明の効果】本発明の液晶表示装置は、液晶セルの裏面側基板の内面に半透過反射膜を設けることにより、外光を利用する反射型表示時には、液晶セルの表面側に配置した第１の偏光板に入射光を直線偏光とする偏光作用と液晶セルの液晶層を通った光を画像光とする検光作用との両方の作用をもたせて、液晶セルの裏面側に配置した第２の偏光板は用いずに表示するものであり、この液晶表示装置によれば、外光を利用する反射型表示を、液晶セルの裏面側に配置した第２の偏光板および前記液晶セルの裏面側基板によって出射光量をロスすることなく行なえるため、外光を利用する反射型表示の際の偏光板および液晶セルの基板での光吸収による光量ロスを少なくし、反射型表示での表示を十分明るくすることができる。

【０１３１】また、本発明の液晶表示装置において、前記液晶セルの両基板の内面にそれぞれ設けられている電極のうち、裏面側基板の内面に設けられている電極に前記半透過反射膜を兼ねさせれば、液晶セルの構造を簡素化するとともにその製造を容易にすることができる。

【０１３２】すなわち、例えば前記液晶セルが、裏面側基板の内面に画素電極と能動素子を配設し、表面側基板の内面に対向電極を設けたアクティブマトリックス型セルであるときは、前記画素電極に半透過反射膜を兼ねさせ、また前記液晶セルが、表面側基板の内面に画素電極と能動素子を配設し、裏面側基板の内面に対向電極を設けたアクティブマトリックス型セルであるときは、前記対向電極に半透過反射膜を兼ねさせればよく、このようにすれば、液晶セルの構造を簡素化できるし、また前記画素電極あるいは対向電極と半透過反射膜とを同時に形成できるから、液晶セルの製造も容易になる。

【０１３３】また、前記液晶セルが、裏面側基板の内面に画素電極と能動素子を配設したアクティブマトリックス型セルであって、前記画素電極に半透過反射膜を兼ねさせる場合、前記能動素子を保護絶縁膜で覆い、半透過反射膜を兼ねる画素電極を前記保護絶縁膜の上に前記能動素子を覆って設けて、前記保護絶縁膜に形成したコンタクト孔において前記能動素子に接続してもよく、このようにすれば、半透過反射膜を兼ねる画素電極の面積を大きくして、反射型表示の際の開口率を上げることができる。

【０１３４】さらに、本発明の液晶表示装置において、前記液晶セルの両基板の内面にそれぞれ設けられている電極はいずれも透明電極であってもよく、その場合は、裏面側基板の内面に設けられた電極の裏面側に、透明な絶縁膜を介して半透過反射膜を設ければよいが、例えば前記液晶セルが、裏面側基板の内面に画素電極と能動素子を配設したアクティブマトリックス型セルである場合、前記画素電極を透明電極とし、この画素電極の裏面側に透明な絶縁膜を介して半透過反射膜を設ければ、この半透過反射膜と前記画素電極およびその間の絶縁膜とによって、非選択期間における画素の保持電圧を補償する補償容量を構成することができる。

【０１３５】また、本発明の液晶表示装置においては、液晶セルの裏面側基板の内面に半透過反射膜を設けているため、この半透過反射膜を拡散反射膜とすることは難しいが、液晶セルの表面側に配置した第１の偏光板の一面が光散乱面となっていれば、前記半透過反射膜の反射面がほぼ鏡面であっても、表示観察者の顔やその背景等の外部像が前記反射面に写って見えることはない。

【０１３６】さらに、本発明の液晶表示装置において、前記半透過反射膜の反射面がほぼ鏡面であれば、反射型表示において液晶セルの液晶層により偏光状態を変えられた光を半透過反射膜によって散乱させてしまうことはなく、また透過型表示においても、第２の偏光板を通っ

て液晶セルにその裏面側から入射する光を半透過反射膜によって散乱させてしまうことはない。

【０１３７】そして、この場合、前記第１の偏光板の表面が光散乱面であれば、反射型表示の際に液晶表示装置にその表面側から入射する光が散乱されてから第１の偏光板の偏光作用により直線偏光になるし、また反射型表示においても透過型表示においても、液晶セルの液晶層を通った光が前記第１の偏光板の検光作用により画像光となってから散乱されるため、入射光が前記第１の偏光板を通って画像光となるまでは光が散乱されることはなく、したがって、品質の良い画像を表示することができる。

【図面の簡単な説明】

【図１】本発明の第１の実施例を示す液晶表示装置の基本構成図。

【図２】同液晶表示装置の一部分の拡大断面図。

【図３】半透過反射膜の第１の例を示すその一部分の断面図。

【図４】図３に示した半透過反射膜の平面図。

【図５】半透過反射膜の第２の例を示すその一部分の断面図。

【図６】半透過反射膜の第３の例を示すその一部分の断面図。

【図７】半透過反射膜の第４の例を示すその一部分の断面図。

【図８】図７に示した半透過反射膜の平面図。

【図９】表面側偏光板の表面の拡大断面図。

【図１０】液晶セルの液晶分子配向方向と、位相差板の遅相軸と、偏光板の透過軸とを示す平面図。

【図１１】反射型表示の際の印加電圧に対する出射光の色変化を示すＣＩＥ色度図。

【図１２】反射型表示の際の電圧－出射率特性図。

【図１３】透過型表示の際の印加電圧に対する出射光の色変化を示すＣＩＥ色度図。

【図１４】透過型表示の際の電圧－出射率特性図。

【図１５】本発明の第２の実施例を示す液晶表示装置の基本構成図。

【図１６】本発明の第３の実施例を示す液晶表示装置の基本構成図。

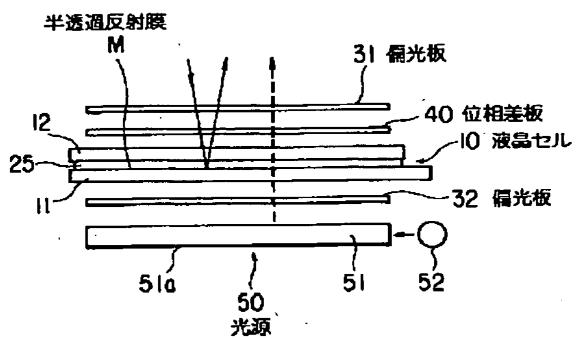
【図１７】本発明の第４の実施例を示す液晶表示装置の基本構成図。

【図１８】従来の液晶表示装置の基本構成図。

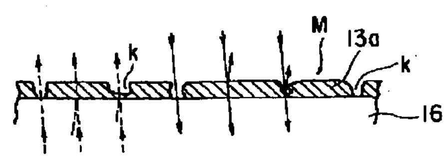
【符号の説明】

１０…液晶セル
１１…裏面側基板
１２…表面側基板
１３…画素電極
１４…ＴＦＴ（能動素子）
２２…配向膜
２３…対向電極
２４…配向膜
２６…液晶
M…半透過反射膜
３１…表面側偏光板（第１の偏光板）
３２…裏面側偏光板（第２の偏光板）
４０…位相差板
５０…光源

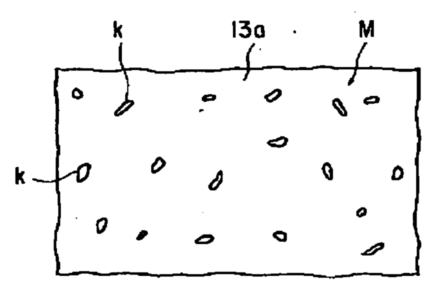
【図１】



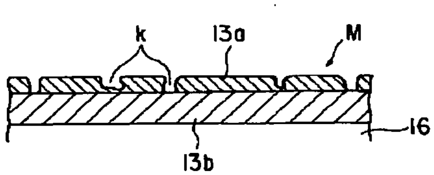

【図３】




【図４】




【図５】



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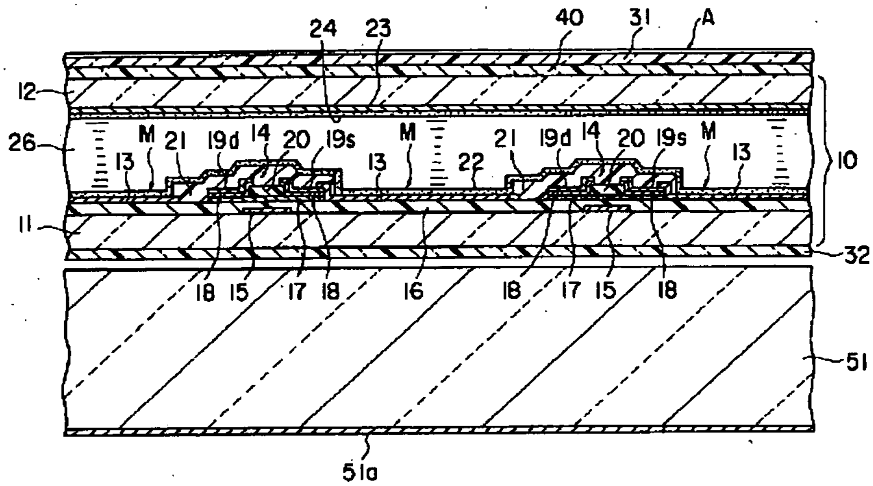


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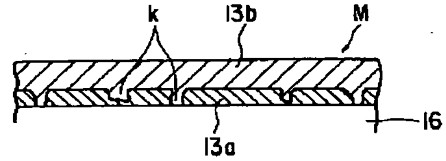


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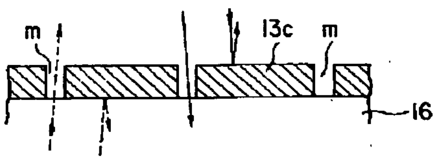


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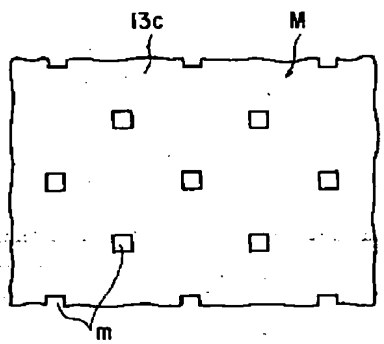


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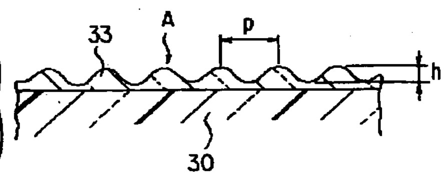


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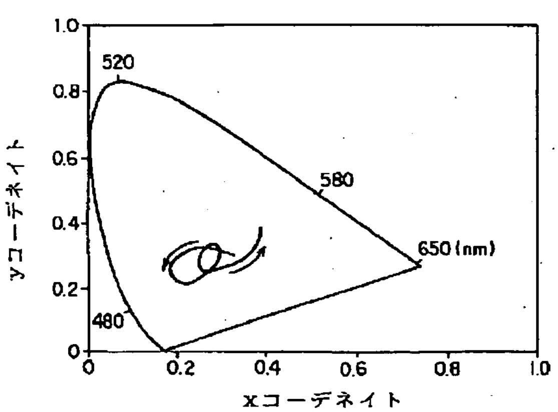


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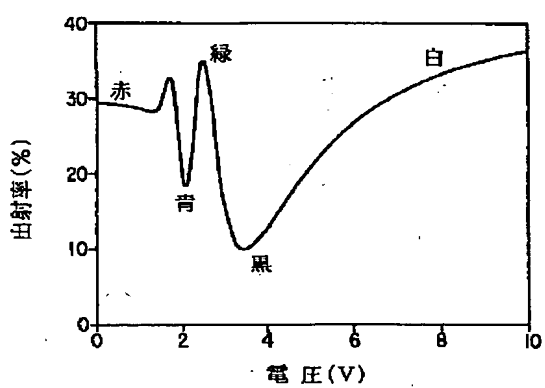

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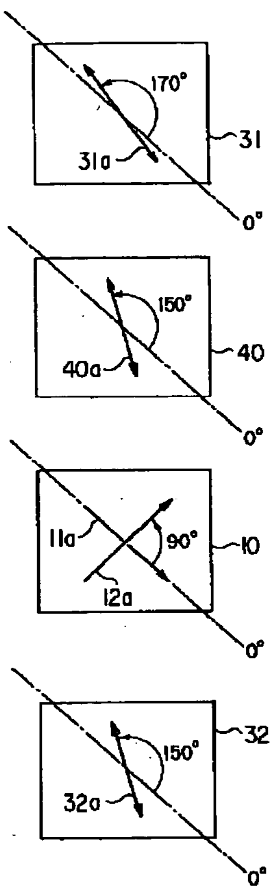


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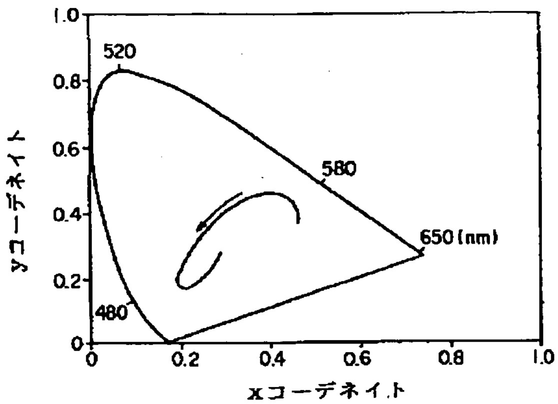


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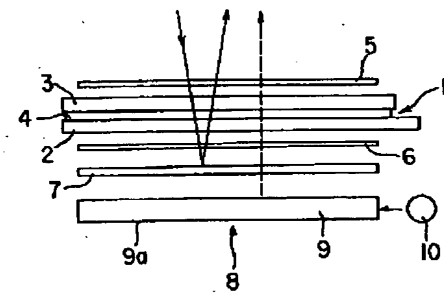


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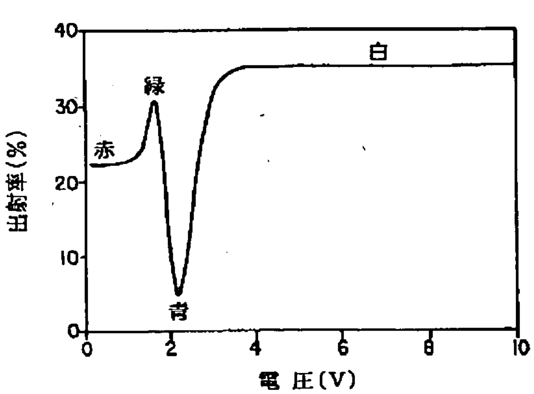

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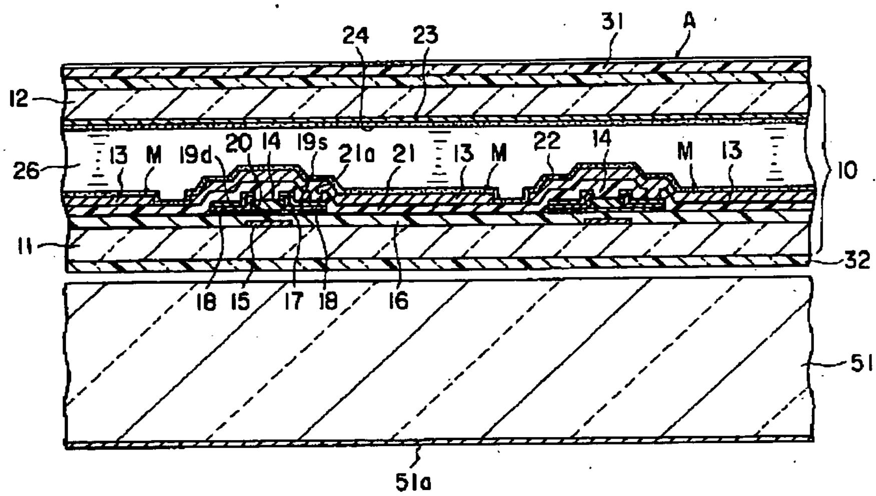
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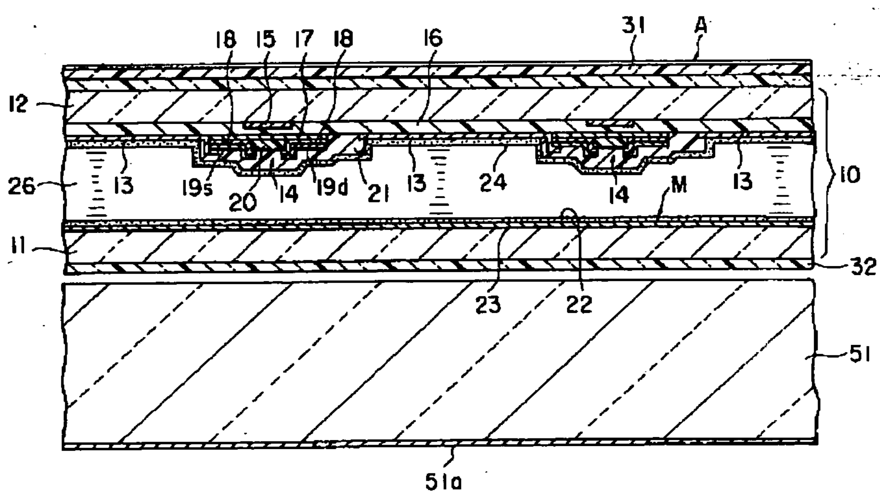
【図16】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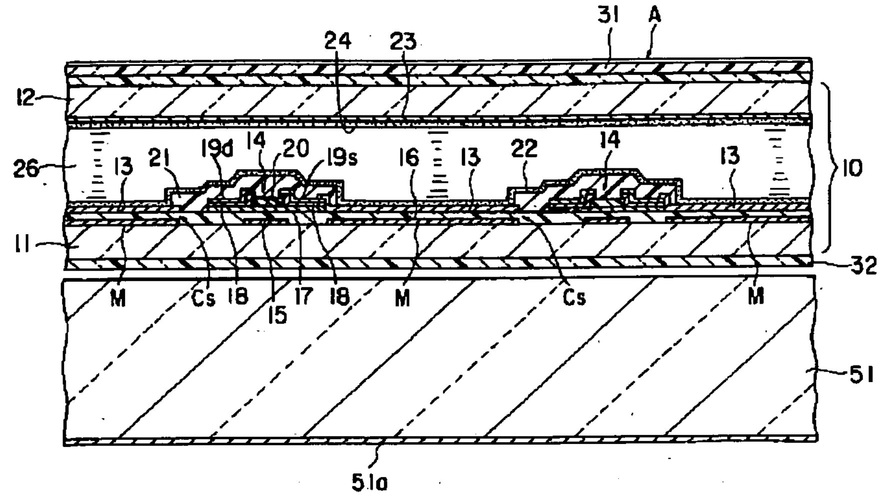
【図１７】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# PATENT ABSTRACTS OF JAPAN

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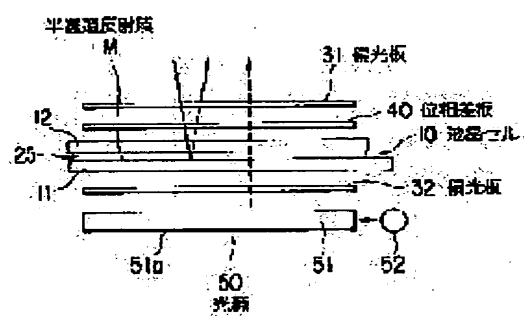
(72)Inventor : AOKI HISASHI
YOSHIDA TETSUSHI

## (54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PURPOSE: To lessen the light quantity loss by light absorption at polarizing plates and substrates and to make display bright at the time of reflection type display utilizing external light by providing the inside surface of the rear surface side substrate of the liquid crystal cell with a translucent reflection film.
CONSTITUTION: Plural pixel electrodes and plural active elements respectively corresponding thereto are disposed in a matrix form in a row direction and column direction on the inside surface of the rear surface side substrate 11 of the liquid crystal cell 10, i.e. the opposite surface of a liquid crystal layer. The pixel electrodes are commonly used as the translucent reflection film M. This translucent reflection film M allows the reflection and transmission of the incident light at certain reflectivity and transmittance. Te external light entering from the front surface side is polarized to linearly polarized light by the front surface side polarizing plate 31 and is made incident on the liquid crystal cell 10. The light past this liquid crystal layer is made incident on the translucent reflection film M and the light reflected by the translucent reflection film M is again made incident on the front surface side polarizing plate 31 after passing the liquid crystal layer. The light transmitted through the polarizing plate 31 is emitted as image light to the front surface side.

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[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

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[Claim(s)]
[Claim 1] The reflective mold display function which is made to reflect the light which uses outdoor daylight and carries out incidence from a front-face side, and is displayed, The liquid crystal cell which it is [ liquid crystal cell ] the liquid crystal display which has the transparency mold display function which is made to carry out incidence of the light from the light source, and displays it from a rear-face side, and made liquid crystal pinch between the transparence substrates of a front flesh-side pair, It consists of the 1st polarizing plate arranged at the front-face side of this liquid crystal cell, and the 2nd polarizing plate arranged at the rear-face side of said liquid crystal cell. And the liquid crystal display characterized by preparing the transflective reflective film which makes the inside of the rear-face side substrate of said liquid crystal cell reflect and penetrate incident light with a certain reflection factor and permeability.
[Claim 2] The liquid crystal display according to claim 1 characterized by the electrode which the electrode for impressing electric field is prepared in the inside of both the substrates of a liquid crystal cell at the liquid crystal layer, respectively, and was prepared in the inside of a rear-face side substrate serving as the transflective reflective film.
[Claim 3] A liquid crystal cell is a liquid crystal display according to claim 2 which is the active-matrix mold cel which arranged in the inside of a rear-face side substrate two or more active elements which correspond to two or more pixel electrode and each [ these ] pixel electrode, respectively, and prepared said each pixel electrode and the counterelectrode which counters in the inside of a front-face side substrate, and is characterized by said pixel electrode serving as the transflective reflective film.
[Claim 4] It is the liquid crystal display according to claim 3 characterized by covering the active element by the protection insulator layer, for the pixel electrode which serves as the transflective reflective film covering said active element, preparing it on said protection insulator layer, and connecting with said active element in the contact hole formed in said protection insulator layer.
[Claim 5] A liquid crystal cell is a liquid crystal display according to claim 3 which is the active-matrix mold cel which arranged in the inside of a front-face side substrate two or more active elements which correspond to two or more pixel electrode and each [ these ] pixel electrode, respectively, and prepared said each pixel electrode and the counterelectrode which counters in the inside of a rear-face side substrate, and is characterized by said counterelectrode serving as the transflective reflective film.
[Claim 6] It is the liquid crystal display according to claim 1 characterized by preparing the electrode for impressing electric field in the inside of both the substrates of a liquid crystal cell at the liquid crystal layer, respectively, and preparing the transflective reflective film in the rear-face side of the electrode which each of these electrodes is transparent electrodes, and was prepared in the inside of a rear-face side substrate through a transparent insulator layer.
[Claim 7] It is the liquid crystal display according to claim 6 which a liquid crystal cell is an active-matrix mold cel which arranged in the inside of a rear-face side substrate two or more active elements which correspond to two or more pixel electrode and each [ these ] pixel electrode, respectively, and prepared said each pixel electrode and the counterelectrode which counters in the inside of a front-face side substrate, and said pixel electrode is a transparent electrode and is characterized by preparing the transflective reflective film in the rear-face side of this pixel electrode through a transparent insulator layer.
[Claim 8] The reflector of the transflective reflective film is a liquid crystal display according to claim 1 characterized by being a mirror plane mostly.
[Claim 9] The liquid crystal display according to claim 1 or 8 characterized by the whole surface of the 1st polarizing plate arranged at the front-face side of a liquid crystal cell being a light-scattering side.
[Claim 10] The liquid crystal display according to claim 9 characterized by the front face of a polarizing plate being a light-scattering side.

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the liquid crystal display which has a reflective mold display function and a transparency mold display function.
[0002]
[Description of the Prior Art] There are some which have the reflective mold display function which is made to reflect the light which uses outdoor daylight, such as the natural light and

indoor illumination light, and carries out incidence from a front-face side as a liquid crystal display, and is displayed, and the transparency mold display function which is made to carry out incidence of the light from the light source, and displays it from a rear-face side.

[0003] The liquid crystal display which has the above-mentioned reflective mold display function and a transparency mold display function has composition as shown in drawing 18 conventionally. While this liquid crystal display arranges polarizing plates 5 and 6 to a that front-face and rear-face side on both sides of a liquid crystal cell 1, respectively, the half mirror 7 which makes incident light reflect and penetrate with a certain reflection factor and permeability to the rear-face side of the polarizing plate 6 prepared in the rear-face side of a liquid crystal cell 1 is arranged, and the light source 8 is established behind said half mirror 7.

[0004] In addition, the above-mentioned liquid crystal cell 1 makes each electrode forming face counter mutually, and joins the transparence substrates 2 and 3 of the pair which formed the orientation film on it while preparing the transparent electrode through the frame-like sealant 4. Liquid crystal is made to pinch between both this substrate 2 and 3, and the molecule of liquid crystal is regulated by said orientation film in each substrate 2 and the direction of orientation on three, and changes orientation into the predetermined orientation condition.

[0005] moreover, the above-mentioned light source 8 -- general -- **** of the above-mentioned half mirror 7 -- it consists of a light guide plate 9 which counters the whole mostly, and a light source lamp 10 arranged towards the end side of this light guide plate 9. It is the thing in which reflective film 9a which consists of vacuum evaporationo (aluminum) film of aluminum etc. was formed at the whole rear face of the transparence plate which consists of acrylic resin etc., and incidence of said light guide plate 9 is carried out to a light guide plate 9 from that end side, the illumination light from the light source lamp 10 can draw the inside of a light guide plate 9, and it carries out outgoing radiation toward a liquid crystal cell 1 from the whole front face of this light guide plate 9.

[0006] In bright location where the quantity of light of outdoor daylight is sufficient, the above-mentioned liquid crystal display performs the reflective mold display using outdoor daylight, and at this time, as the continuous-line arrow head showed to drawing 18 , the outdoor daylight which carries out incidence to a liquid crystal display from that front-face side turns into the linearly polarized light by the polarization of the polarizing plate 5 by the side of a front face, and carries out incidence of it to a liquid crystal cell 10.

[0007] On the other hand, since the orientation condition of the liquid crystal molecule of a liquid crystal cell 1 changes with the electrical potential differences impressed to inter-electrode [ of both the substrates 2 and 3 ] and the birefringence effectiveness of a liquid crystal layer changes according to the orientation condition of this liquid crystal molecule, the linearly polarized light which carried out incidence to the liquid crystal cell 1 turns into light of a polarization condition according to the orientation condition of a liquid crystal molecule, outgoing radiation of the liquid crystal cell 1 is carried out, and this light carries out incidence to the polarizing plate 6 by the side of a rear face.

[0008] And this light turns into image light according to a light analysis operation of the rear-face side polarizing plate 6, and carries out incidence to a half mirror 7, and the light reflected by the half mirror 7 among that light carries out outgoing radiation to the front-face side of a liquid crystal display through said rear-face side polarizing plate 6, a liquid crystal cell 1, and the front-face side polarizing plate 5.

[0009] Moreover, if the above-mentioned liquid crystal display can be displayed using the illumination light from the light source 8 and makes the light source lamp 10 turn on also in a dark location with little quantity of light of outdoor daylight As the broken-line arrow head showed to drawing 18 , the light which the illumination light from the light source 8 carried out incidence to the half mirror 7, and penetrated this half mirror 7 It becomes the linearly polarized light by the polarization of the rear-face side polarizing plate 6, and incidence is carried out to a liquid crystal cell 10, and it becomes the light of a polarization condition according to the orientation condition of that liquid crystal molecule, and incidence is carried out to the front-face side polarizing plate 6, and this light turns into image light according to a light analysis operation of the front-face side polarizing plate 5, and carries out outgoing radiation to the front-face side of a liquid crystal display.

[0010]

[Problem(s) to be Solved by the Invention] However, it had the problem that the above-mentioned conventional liquid crystal display had the large loss of the light in the case of the reflective mold display using outdoor daylight, therefore its display by reflective mold display was dark. The light which carried out incidence carries out incidence of this to a liquid crystal display at a half mirror 7 through the front-face side polarizing plate 5, a liquid crystal cell 1, and the rear-face side polarizing plate 6 from the

front-face side. By the time the light which the light reflected by this half mirror 7 is for carrying out outgoing radiation to the front-face side of a liquid crystal display through said rear-face side substrate 6, a liquid crystal cell 1, and the front-face side polarizing plate 5, therefore carried out incidence from the front-face side carries out outgoing radiation to a front-face side again Since it passes also along the substrates 2 and 3 of both liquid crystal cells 1 a total of 4 times by a unit of 2 times, respectively while passing along the polarizing plates 5 and 6 of a front flesh side a total of 4 times by a unit of 2 times, respectively, the quantity of light loss by the light absorption in polarizing plates 5 and 6 and the substrates 2 and 3 of a liquid crystal cell 1 will be large, and a display will become dark.

[0011] This invention aims at offering what can lessen the quantity of light loss by the light absorption in the polarizing plate in the case of the reflective mold display using outdoor daylight, and the substrate of a liquid crystal cell as a liquid crystal display which has a reflective mold display function using outdoor daylight, and a transparency mold display function using the light from the light source, and can give an indication by reflective mold display sufficiently bright.

[0012]

[Means for Solving the Problem] The liquid crystal display of this invention is characterized by to prepare the transflective reflective film which it consists [ film ] of the liquid crystal cell which made liquid crystal pinch between the transparence substrates of a front flesh-side pair, the 1st polarizing plate arranged at the front-face side of this liquid crystal cell, and the 2nd polarizing plate arranged at the rear-face side of said liquid crystal cell, and makes the inside of the rear-face side substrate of said liquid crystal cell reflect and penetrate incident light with a certain reflection factor and permeability.

[0013] The electrode prepared in the inside of a rear-face side substrate among the electrodes prepared in the inside of both the substrates of said liquid crystal cell, respectively may be made to serve as said transflective reflective film in the liquid crystal display of this invention.

[0014] In this case, said liquid crystal cell arranges two or more active elements which correspond to the inside of a rear-face side substrate at two or more pixel electrode and each [ these ] pixel electrode, respectively. When it is the active-matrix mold cel which prepared said each pixel electrode and the counterelectrode which counters in the inside of a front-face side substrate What is necessary is for said liquid crystal cell to arrange a pixel electrode and an active element in the inside of a front-face side substrate, and just to make said counterelectrode serve as the transflective reflective film that what is necessary is just to make said pixel electrode serve as the transflective reflective film, when it is the active-matrix mold cel which prepared the counterelectrode in the inside of a rear-face side substrate.

[0015] Moreover, a liquid crystal cell is an active-matrix mold cel which arranged the pixel electrode and the active element in the inside of a rear-face side substrate, and when making said pixel electrode serve as the transflective reflective film, said active element may be covered by the protection insulator layer, on said protection insulator layer, said active element may be covered, the pixel electrode which serves as the transflective reflective film may be prepared, and you may connect with said active element in the contact hole formed in said protection insulator layer.

[0016] Furthermore, in the liquid crystal display of this invention, each electrode prepared in the inside of both the substrates of said liquid crystal cell, respectively may be a transparent electrode, and should just prepare the transflective reflective film in the rear-face side of the electrode prepared in the inside of a rear-face side substrate through a transparent insulator layer in that case.

[0017] What is necessary is to use said pixel electrode as a transparent electrode, and just to prepare the transflective reflective film in the rear-face side of this pixel electrode through a transparent insulator layer, when it is the active-matrix mold cel to which said liquid crystal cell arranged the pixel electrode and the active element in the inside of a rear-face side substrate in this case.

[0018] Moreover, as for the reflector of said transflective reflective film, in the liquid crystal display of this invention, it is desirable that it is a mirror plane mostly. Moreover, said front-face side polarizing plate has that desirable from which that whole surface is a light-scattering side, and this polarizing plate has that more more desirable still that front face of whose is a light-scattering side.

[0019]

[Function] The liquid crystal display of this invention is what performs the reflective mold display which uses outdoor daylight in bright location where the quantity of light of outdoor daylight is sufficient. At this time While the outdoor daylight which carries out incidence to a liquid crystal display from the front-face side turns into the linearly polarized light by the polarization of the 1st polarizing plate arranged at the front-face side of a liquid crystal cell and carries out incidence to a liquid crystal cell

Incidence is carried out to the transflective reflective film with which the light which passed along that liquid crystal layer is prepared in the inside of the rear-face side substrate of a liquid crystal cell, the light reflected by this transflective reflective film carries out incidence to said 1st polarizing plate through a liquid crystal layer again, the light which penetrates this polarizing plate turns into image light, and outgoing radiation is carried out to the front-face side of a liquid crystal display.

[0020] This liquid crystal display is what the quantity of light of outdoor daylight can display as also in few dark locations using the light from the light source. Moreover, then The light from the light source turns into the linearly polarized light by the polarization of the 2nd polarizing plate arranged at the rear-face side of a liquid crystal cell, carry out incidence to a liquid crystal cell from the rear-face side, and the light which penetrated said transflective reflective film carries out incidence to liquid crystal **** at the 1st polarizing plate of the above. The light which penetrates this polarizing plate turns into image light, and carries out outgoing radiation to the front-face side of a liquid crystal display.

[0021] namely, at the time of the reflective mold display which uses outdoor daylight by preparing the transflective reflective film in the inside of the rear-face side substrate of a liquid crystal cell, the liquid crystal display of this invention The operation with both light analysis operations which make image light polarization which makes incident light the linearly polarized light, and light which passed along the liquid crystal layer of a liquid crystal cell is given to the 1st polarizing plate arranged to the front-face side of a liquid crystal cell. Display the 2nd polarizing plate arranged to the rear-face side of a liquid crystal cell, without using, and according to this liquid crystal display Since it can carry out without losing the outgoing radiation quantity of light with the 2nd polarizing plate which has arranged the reflective mold display using outdoor daylight to the rear-face side of a liquid crystal cell, and the rear-face side substrate of said liquid crystal cell, The quantity of light loss by the light absorption in the polarizing plate in the case of the reflective mold display using outdoor daylight and the substrate of a liquid crystal cell can be lessened, and an indication by reflective mold display can be given sufficiently bright.

[0022] Moreover, in the liquid crystal display of this invention, if the electrode prepared in the inside of a rear-face side substrate among the electrodes prepared in the inside of both the substrates of said liquid crystal cell, respectively is made to serve as said transflective reflective film, while simplifying the structure of a liquid crystal cell, the manufacture can be made easy.

[0023] Namely, when said liquid crystal cell is an active-matrix mold cel which arranged the pixel electrode and the active element in the inside of a rear-face side substrate, and prepared the counterelectrode in the inside of a front-face side substrate, [ for example, ] Make said pixel electrode serve as the transflective reflective film, and said liquid crystal cell arranges a pixel electrode and an active element in the inside of a front-face side substrate. When it is the active-matrix mold cel which prepared the counterelectrode in the inside of a rear-face side substrate That what is necessary is just to make said counterelectrode serve as the transflective reflective film, if it does in this way, since the structure of a liquid crystal cell can be simplified and said pixel electrode or counterelectrode, and the transflective reflective film can be formed in coincidence, manufacture of a liquid crystal cell will also become easy.

[0024] Moreover, said liquid crystal cell is an active-matrix mold cel which arranged the pixel electrode and the active element in the inside of a rear-face side substrate. When making said pixel electrode serve as the transflective reflective film, said active element is covered by the protection insulator layer. If may cover said active element, the pixel electrode which serves as the transflective reflective film may be prepared on said protection insulator layer, you may connect with said active element in the contact hole formed in said protection insulator layer and it does in this way Area of the pixel electrode which serves as the transflective reflective film can be enlarged, and the numerical aperture in the case of a reflective mold display can be gathered.

[0025] In the liquid crystal display of this invention, each electrode prepared in the inside of both the substrates of said liquid crystal cell, respectively may be a transparent electrode. Furthermore, in that case Although what is necessary is just to prepare the transflective reflective film in the rear-face side of the electrode prepared in the inside of a rear-face side substrate through a transparent insulator layer For example, if said pixel electrode is used as a transparent electrode and the transflective reflective film is prepared in the rear-face side of this pixel electrode through a transparent insulator layer when said liquid crystal cell is an active-matrix mold cel which arranged the pixel electrode and the active element in the inside of a rear-face side substrate The compensation capacitance which compensates the maintenance electrical potential difference of the pixel in a non-selection period by this transflective reflective

film, said pixel electrode, and the insulator layer in the meantime can be constituted.

[0026] Moreover, since the transflective reflective film is prepared in the inside of the rear-face side substrate of a liquid crystal cell in the liquid crystal display of this invention, As for using this transflective reflective film as the diffuse reflection film, although it is difficult, if the whole surface of the 1st polarizing plate arranged to the front-face side of a liquid crystal cell is a light-scattering side, even if the reflector of said transflective reflective film is a mirror plane mostly, external images, such as a display observer's face and its background, are reflected to said reflector, and do not appear.

[0027] Furthermore, in the liquid crystal display of this invention, if the reflector of said transflective reflective film is a mirror plane mostly, the light which the light which was able to change the polarization condition by the liquid crystal layer of a liquid crystal cell in the reflective mold display is not scattered with the transflective reflective film, and carries out incidence to a liquid crystal cell from the rear-face side through the 2nd polarizing plate also in a transparency mold display will not be scattered with the transflective reflective film.

[0028] And if the front face of said 1st polarizing plate is a light-scattering side, after the light which carries out incidence to a liquid crystal display from that front-face side in the case of a reflective mold display will be scattered about in this case, become the linearly polarized light by the polarization of the 1st polarizing plate, and Moreover, since it is scattered about after the light which passed along the liquid crystal layer of a liquid crystal cell also in the transparency mold display also in the reflective mold display turns into image light according to a light analysis operation of said 1st polarizing plate, Light is not scattered about, therefore a quality image can be displayed until incident light turns into image light through said 1st polarizing plate.

[0029]

[Example]

[1st example] drawing 1 - drawing 14 show the 1st example of this invention, drawing 1 is the basic block diagram of a liquid crystal display, and drawing 2 is some expanded sectional views of said liquid crystal display.

[0030] The liquid crystal display of this example is what displays a color picture using the birefringence refraction effectiveness. While arranging the 1st polarizing plate (henceforth a front-face side polarizing plate) 31 to the front-face side (it sets to drawing and is the bottom) of a liquid crystal cell 10 and arranging the 2nd polarizing plate (henceforth a rear-face side polarizing plate) 32 to the rear-face side (it sets to drawing and is the bottom) of said liquid crystal cell 10 The phase contrast plate 40 is arranged between said liquid crystal cell 10 and said front-face side polarizing plate 31, the light source 50 is further arranged behind said rear-face side polarizing plate 32, and it is constituted.

[0031] First, if the above-mentioned liquid crystal cell 10 is explained, this liquid crystal cell 10 is an active-matrix mold cel, and uses that to which twist orientation of the molecule of liquid crystal 26 was carried out between both the substrates 11 and 12 in this example.

[0032] This liquid crystal cell 10 makes liquid crystal 26 pinch between the transparence substrate 11 of a pair which consists of glass etc., and 12, two or more active elements 14 which correspond to two or more pixel electrode 13 and each [ these ] pixel electrode 13, respectively are arranged in the line writing direction and the direction of a train in the shape of a matrix among the substrates 11 and 12 of a pair at the inside of the substrate 11 by the side of a rear face, i.e., an opposed face with a liquid crystal layer, and the transparent orientation film 22 is formed on it.

[0033] The above-mentioned active element 14 is TFT (thin film transistor). This TFT14 The gate electrode 15 formed on the substrate 11, and this gate electrode 15 Wrap gate dielectric film 16, The i-type semiconductor film 17 which consists of a-Si which was made to counter with said gate electrode 15, and was formed on this gate dielectric film 16 (amorphous silicon), a-Si which doped the impurity in the both-sides section of this i-type semiconductor film 17 etc. from it consists of 19s of source electrodes and 19d of drain electrodes formed through the becoming n-type-semiconductor film 18, and this TFT14 is covered by the protection insulator layer 21.

[0034] In addition, 20 is the blocking insulator layer formed on the channel field of the i-type semiconductor film 17, and this blocking insulator layer 20 is formed in order to protect the i-type semiconductor film 17 at the time of patterning of the n-type-semiconductor film 18.

[0035] the transparence insulator layer which the gate dielectric film 16 of the above TFT14 turns into from Si N (silicon nitride) etc. -- it is -- this gate dielectric film 16 -- a substrate 11 -- it is mostly formed over the whole surface.

[0036] Moreover, although not illustrated, on the above-mentioned rear-face side substrate 11, the gate line (address line) which supplies a gate signal to the gate electrode 15 of the above TFT14, and the data line which supplies the data signal according to image data to 19d of said drain electrodes of TFT14 are wired.

[0037] The above-mentioned gate line is formed on the substrate 11 at the gate electrode 15 of the above TFT14, and one, and this gate line is covered with said gate dielectric film 16 except for that terminal area. Moreover, the above-mentioned data line is formed on said gate dielectric film 16, and this data line is connected with 19d of drain electrodes of the above TFT14.

[0038] And on the above-mentioned gate dielectric film 16, the above-mentioned pixel electrode 13 avoids the above TFT14, and is formed, and each pixel electrode 13 is connected to 19s of source electrodes of TFT14 which correspond in the end section, respectively.

[0039] Moreover, the above-mentioned pixel electrode 13 serves as the transflective reflective film M, and the reflector is a mirror plane mostly. Like the commercial half mirror, this transflective reflective film M makes incident light reflect and penetrate with a certain reflection factor and permeability, and is using the pixel electrode 13 as the transflective reflective film M whose permeability is 5 - 20% in this example. In addition, a reflection factor should just be about 14% or more.

[0040] This transflective reflective film M is aluminum. Or aluminum It is formed by metal membranes, such as a system alloy, or considers as the cascade screen of transparence electric conduction film, such as ITO film, and a metal membrane. **** which drawing 3 and drawing 4 are some of those sectional views and top views showing the 1st example of the transflective reflective film M, and this transflective reflective film M formed with the sputtering system -- it consists of thin metal thin film 13a.

[0041] namely, this transflective reflective film M -- that substrate side (here gate dielectric film 16) top -- a sputtering system -- metal particles -- **** -- the hole with which it is made to deposit thinly and metal particles have not deposited the transflective reflective film M which it was formed and was shown in drawing -- it consists of metal thin film 13a dotted with the minute defective parts k, such as a defect and a reentrant defect in which the deposition thickness of metal particles is thin. In addition, said defective part k is an irregular configuration, and the magnitude and a distribution condition change according to the membrane formation thickness of metal thin film 13a.

[0042] This transflective reflective film M the incident light from the front-face side shown in drawing 3 by the continuous-line arrow head Moreover, the incident light from the rear-face side shown by the broken-line arrow head is also the thing made to reflect and penetrate with a certain reflection factor and permeability. A part of light which carried out incidence to the film part (parts other than a defective part k) of the above-mentioned metal thin film 13a is reflected by the film surface of metal thin film 13a, and the light of a certain amount penetrates metal thin film 13a, and the remaining light is absorbed by metal thin film 13a.

[0043] since the reentrant defective part with the deposition thickness of metal particles thin among the defective parts k of the above-mentioned metal thin film 13a, on the other hand, has very thin metal membrane thickness -- the reflection and the absorbed amount in this reentrant defective part -- **** -- it is small, therefore that most penetrates the light which carried out incidence to this reentrant defective part. moreover, the hole which metal particles have not deposited -- as for the light which carried out incidence to the defective part, the all serve as the transmitted light.

[0044] however, the gross area of the defective part k per unit area of the above-mentioned metal thin film 13a -- the area of the film part per said unit area -- comparing -- **** -- it is small, therefore the permeability of the transflective reflective film M is almost governed by the permeability of the film part of metal thin film 13a.

[0045] And since the permeability of the film part of said metal thin film 13a is decided by the metaled optical constant and the thickness which are that ingredient, if this metal thin film 13a membrane formation thickness is chosen, it can obtain the transflective reflective film M whose permeability mentioned above is 5 - 20%.

[0046] in addition, the transflective reflective film M shown in drawing 3 and drawing 4 -- a hole although it is what consists of metal thin film 13a dotted with the minute defective parts k, such as a defect and a reentrant defect, -- this transflective reflective film M -- said hole -- you may be the metal thin film which almost has neither a defect nor a reentrant defect, and even in such a case, if the thickness of said metal thin film is about 20nm or less, this metal thin film can be used as transflective reflective film M.

[0047] Namely, although the metal thin film formed in membrane formation of the metal thin film by the sputtering system as the membrane formation thickness is about 10nm or less turns into film with a hole defect or a reentrant defect if membrane formation thickness is made thick to about 10nm or more -- it -- following -- said hole -- if the number of distribution also decreases and it becomes the above thickness to some extent, while the magnitude of a defect or a reentrant defect becomes small -- a hole -- a defect and a reentrant defect are almost closed and serve as film with an almost flat front face.

[0048] If that example is given, it is aluminum about said metal thin film. Or aluminum-Ti When forming with an alloy (titanium), the metal thin film which formed membranes in thickness of 8.5nm is film with the minute defective part k as shown in drawing 3 and drawing 4 R> 4, the permeability of this metal thin film is about 10 - 20%, and sheet resistance is 53ohms.

[0049] Moreover, said aluminum Or aluminum-Ti The metal thin film which formed the alloy in thickness of 17.0nm is film with the almost flat front face which almost has neither the above-mentioned hole defect nor a reentrant defect, the permeability of this metal thin film is about 5% or less, and sheet resistance is 14ohms.

[0050] In addition, although the permeability of the above-mentioned transflective reflective film M should just be 5 - 20% of range mentioned above, in order to use the light from the light source 50 more effectively, it is desirable [ permeability ] to make said permeability 7% or more still more preferably 6% or more.

[0051] However, although the sheet resistance will become high in order to make the permeability of the transflective reflective film M high in this way, and to have to make thickness of said metal thin film to some extent thin, the cascade screen, then said sheet resistance of the transparence electric conduction film and a high reflection factor metal membrane, such as ITO film, can be made low for said transflective reflective film M.

[0052] That is, the transflective reflective film M which drawing 5 and drawing 6 are some of the sectional views showing the 2nd and 3rd examples of the transflective reflective film M, respectively, and was shown in drawing 5 forms ITO film 13b with a sputtering system on the substrate side (gate dielectric film 16), and forms metal thin film 13a shown on it at drawing 3 and drawing 4 .

[0053] Moreover, the transflective reflective film M shown in drawing 6 forms metal thin film 13a shown on the substrate side (gate dielectric film 16) at drawing 3 and drawing 4 , and forms ITO film 13b with a sputtering system on it.

[0054] The sheet resistance of ITO film 13b of the transflective reflective film M shown in these drawing 5 and drawing 6 is 40ohms in the case where thickness of this ITO film 13b is set to 50nm, therefore even if the sheet resistance of said metal thin film 13a is high to some extent, it can make low apparent sheet resistance of the transflective reflective film M.

[0055] in addition, metal thin film 13a of the transflective reflective film M shown in drawing 5 and drawing 6 -- a hole -- although it is the metal thin film with which it is dotted with the minute defective parts k, such as a defect and a reentrant defect, this metal thin film may be a metal thin film with the almost flat front face which does not almost have said defective part k.

[0056] Furthermore, drawing 7 and drawing 8 are some of those sectional views and top views showing the 4th example of the transflective reflective film M, and this transflective reflective film M consists of light impermeability metal membrane 13c which you made it dotted with the minute opening m, and was prepared.

[0057] That is, this transflective reflective film M is aluminum by the sputtering system on that substrate side (gate dielectric film 16). Or aluminum Metal membrane 13c which consists of a system alloy etc. is formed in the thickness (about 300nm) which does not make light penetrate, and much minute openings m are formed in this metal membrane 13c by the photolithography method.

[0058] This transflective reflective film M makes the light which was reflected in respect of the metal and carried out incidence of the light which carried out incidence to the film part (parts other than Opening m) of said metal membrane 13c to the opening m part penetrate, and the incident light from the front-face side shown in drawing 7 by the continuous-line arrow head and the incident light from the rear-face side shown by the broken-line arrow head are reflected and penetrated with a certain reflection factor and permeability.

[0059] Since this transflective reflective film M consists of comparatively thick metal membrane 13c which formed membranes in the thickness which does not make light penetrate, it has the advantage that sheet resistance is low. Moreover, the permeability of this transflective reflective film M is decided by the gross area of the opening m distributed in the unit area of the above-mentioned metal membrane 13c.

[0060] However, in this transflective reflective film M, if the area of each opening m is large Since an opening m part serves as a sunspot and it is visible, when incidence of the light is carried out from a front-face side and the reflected light is observed, and said opening m part serves as the luminescent spot and it is visible, when incidence of the light is carried out from a rear-face side and the transmitted light is observed, In order are not conspicuous and to carry out such a sunspot and the luminescent spot, it is desirable to set width of face of each opening m to about 3 micrometers or less, and to obtain desired permeability with the number.

[0061] And the above-mentioned pixel electrode 13 forms the transflective reflective film M of either the 1st - the 4th example mentioned above on gate dielectric film 16, carries out patterning of this transflective reflective film M by the

photolithography method, and is formed. In addition, when forming a pixel electrode by the transflective reflective film M shown in drawing 6 and drawing 7 , formation of the opening m to the metal membrane 13c and patterning to the pixel electrode 13 can be performed to coincidence.

[0062] On the other hand, the transparent counterelectrode 23 which becomes the inside of the front-face side substrate 12 of a liquid crystal cell 10, i.e., an opposed face with a liquid crystal layer, from the ITO film etc. is formed, and the transparent orientation film 24 is formed on it. In addition, let said counterelectrode 23 be the electrode of the shape of one-sheet film which counters each pixel electrodes of all of the above-mentioned rear-face side substrate 11.

[0063] And the above-mentioned rear-face side substrate 11 and the front-face side substrate 12 are joined through the frame-like sealant 25 (refer to drawing 1 ) at the periphery edge, and both the substrates 11 and the field surrounded by said sealant 25 between 12 are filled up with liquid crystal 26.

[0064] A dielectric anisotropy is a forward pneumatic liquid crystal, with the orientation film 22 and 24 prepared in both the substrates 11 and 12, this liquid crystal 26 has each substrate 11 and the direction of orientation on 12 regulated, and twist orientation is carried out for the molecule of this liquid crystal 26 between both the substrates 11 and 12. In addition, the above-mentioned orientation film 22 and 24 is level orientation film which consists of polyimide etc., and orientation processing by rubbing is performed to the film surface.

[0065] Moreover, among the polarizing plates 31 and 32 of the above-mentioned table flesh side, the transparent membrane 33 to which a polarizing plate usual in the rear-face side polarizing plate 32 and the front-face side polarizing plate 31 have minute irregularity in the front face of a polarizing plate 31 as that whole surface, for example, a front face, is a polarizing plate used as the light-scattering side A and the light-scattering side A of this front-face side polarizing plate 31 expanded and showed some of those cross sections to drawing 9 is formed, and it is constituted.

[0066] The above-mentioned transparent membrane 33 consists of resin with the high light transmittance of acrylic resin etc. this transparent membrane 33 How to carry out decalcomania of the resin ingredient to the 31st page of a polarizing plate, and to make it harden it using the printing version with minute irregularity, It is formed by either the approach of stiffening, after applying said resin ingredient to homogeneity thickness at the 31st page of a polarizing plate and attaching irregularity by mold push, or the method of making the 31st page of a polarizing plate apply and harden what mixed the transparent particle which becomes said resin ingredient from a silica etc.

[0067] The average pitch p of 1-5 micrometers and irregularity of average height (difference of height of concave surface and convex) h of the irregularity of this transparent membrane 33 is 5-40 micrometers, and the Hayes value of the above-mentioned light-scattering side A is 9 - 14%.

[0068] In addition, the above-mentioned Hayes value is JIS. K It is the measured value by the integrating-sphere type light transmission measuring device (hazemeter) according to 6714. This Hayes value is computed by the degree type.

[0069] all light transmission; -- Tt(%) =T2 / T1 parallel-ray permeability; -- Tp(%) =Tt-Td luminous-diffuse-transmittance; -- Td(%) = [T-four-T3 x(T2 / T1)]/T1 Hayes value;H (%) =(Td/Tt) x100T1 ; Amount of incident rays T2 ; All amount T3 of beam-of-light transmitted lights ; Amount T four of diffused lights of a measuring device ; The amount of diffused lights and the above-mentioned phase contrast plate 40 by the test piece (transparent membrane 31) and the measuring device It consists of uniaxial stretched films, such as a polycarbonate. This phase contrast plate 40 It is arranged where the lagging axis (extension shaft) of the phase contrast plate 40 and the transparency shaft of the front-face side polarizing plate 31 are shifted aslant [ predetermined include-angle ] between the front-face side polarizing plate 31 arranged at the front-face side of the above-mentioned liquid crystal cell 10, and said liquid crystal cell 10.

[0070] In addition, said phase contrast plate 40 was pasted up on the front face (external surface of the front-face side substrate 12) of a liquid crystal cell 10, and the front-face side polarizing plate 30 is pasted up on the front face of said phase contrast plate 40, and the rear-face side polarizing plate 32 is pasted up on the rear face (external surface of the rear-face side substrate 11) of a liquid crystal cell 10.

[0071] moreover, the thing which has the above-mentioned light source [ be / the same as that of the light source used for the conventional liquid crystal display / it ] 50 -- it is -- **** of the above-mentioned rear-face side polarizing plate 32 -- it consists of a light guide plate 51 which counters the whole mostly, and a light source lamp 52 which emits the white light arranged towards the end side of this light guide plate 51.

[0072] the rear-face whole of the transparence plate with which said light guide plate 51 consists of acrylic resin etc. -- aluminum etc. -- it is the thing in which reflective film 51a which consists of vacuum evaporationo film was formed, and

incidence of the illumination light from the light source lamp 52 is carried out to a light guide plate 51 from that end side, and it can draw the inside of a light guide plate 51, and it carries out outgoing radiation toward a liquid crystal cell 10 from the whole front face of this light guide plate 51.

[0073] In the liquid crystal display of this example, and the above-mentioned front-face side polarizing plate 31 While shifting and arranging the transparency shaft aslant [ predetermined include-angle ] to the direction of orientation of the liquid crystal molecule on the front-face side substrate 12 of a liquid crystal cell 10 (the direction of rubbing of the orientation film 24) Shift the lagging axis (extension shaft) aslant [ predetermined include-angle ] to the transparency shaft of said front-face side polarizing plate 31, and the above-mentioned phase contrast plate 40 is arranged. Furthermore, the transparency shaft was shifted aslant [ predetermined include-angle ] to the direction of orientation of the liquid crystal molecule on the rear-face side substrate 11 of a liquid crystal cell 10 (the direction of rubbing of the orientation film 22), and the rear-face side polarizing plate 32 is arranged.

[0074] In addition, in this example, the direction of liquid crystal molecular orientation on the rear-face side substrate 11 of a liquid crystal cell 10 was made into the direction of 0 degree of azimuths, and the direction of liquid crystal molecular orientation on the front-face side substrate 12 of a liquid crystal cell 10, the transparency shaft orientations of polarizing plates 31 and 32, and the direction of a lagging axis of the phase contrast plate 40 are set up on the basis of this direction.

[0075] That is, drawing 10 is the top view showing the direction of liquid crystal molecular orientation of the liquid crystal cell 10 in the above-mentioned liquid crystal display, the lagging axis of the phase contrast plate 40, and the transparency shaft of polarizing plates 31 and 32, it sets to drawing and the direction of orientation of the liquid crystal [ a / 11] molecule on the rear-face side substrate 11 of a liquid crystal cell 10 and 12a show the direction of orientation of the liquid crystal molecule on the front-face side substrate 12 of a liquid crystal cell 10.

[0076] Like this drawing 10 , direction of liquid crystal molecular orientation 12a on the front-face side substrate 12 of a liquid crystal cell 10 was seen from the front-face side, and is shifted in the counterclockwise direction about 90 degrees to the direction of 0 degree of azimuths of direction of liquid crystal molecular orientation 11a on the rear-face side substrate 11, i.e., the direction, and twist orientation of the molecule of liquid crystal 26 is carried out on about 90-degree twist square between both the substrates 11 and 12.

[0077] Moreover, in 31a, in drawing 10 , the transparency shaft of the front-face side polarizing plate 31 and 40a show the lagging axis of the phase contrast plate 40. Transparency shaft 31a of the front-face side polarizing plate 31 is seen from a front-face side to the direction of the 0 degree of the above-mentioned azimuths. In the counterclockwise direction About 170-degree direction, Lagging-axis 40a of the phase contrast plate 40 is seen from a front-face side to the direction of 0 degree of azimuths, and is in the counterclockwise direction in about 150-degree direction, therefore to transparency shaft 31a of the front-face side polarizing plate 31, lagging-axis 40a of the phase contrast plate 40 was seen from the front-face side, and has shifted in the clockwise direction aslant [ about 20-degree ].

[0078] Furthermore, in drawing 10 , 32a shows the transparency shaft of the rear-face side polarizing plate 32, and transparency shaft 32a of this rear-face side polarizing plate 32 is seen from a front-face side to the direction of the 0 degree of the above-mentioned azimuths, and is in the counterclockwise direction in about 150-degree direction.

[0079] This liquid crystal display is what performs the reflective mold display which uses said outdoor daylight in bright location where the quantity of light of outdoor daylight (natural light or indoor illumination light) is sufficient. At this time As the continuous-line arrow head showed to drawing 1 R> 1, while the outdoor daylight which carries out incidence to a liquid crystal display from the front-face side turns into the linearly polarized light by the polarization of the front-face side polarizing plate 31 and carries out incidence to a liquid crystal cell 10 Carry out incidence to the transflective reflective film M (pixel electrode 13) with which the light which passed along that liquid crystal layer is prepared in the inside of the rear-face side substrate 11 of a liquid crystal cell 10, and the light reflected by this transflective reflective film M carries out incidence to said front-face side polarizing plate 31 through a liquid crystal layer again. The light which penetrates this polarizing plate 31 turns into image light, and carries out outgoing radiation to the front-face side of a liquid crystal display.

[0080] This liquid crystal display is what the quantity of light of outdoor daylight can display as also in few dark locations using the light from the light source 50. Moreover, then As the broken-line arrow head showed to drawing 1 , the light from the light source 50 turns into the linearly

polarized light by the polarization of the rear-face side polarizing plate 32, and carries out incidence to a liquid crystal cell 10. The light which penetrated the transflective reflective film M (pixel electrode 13) prepared in the inside of that rear-face side substrate 11 carries out incidence to the above-mentioned front-face side polarizing plate 31 through a liquid crystal layer, the light which penetrates this polarizing plate 31 turns into image light, and outgoing radiation is carried out to the front-face side of a liquid crystal display.
[0081] namely, at the time of the reflective mold display which uses outdoor daylight by forming the transflective reflective film M in the inside of the rear-face side substrate 11 of a liquid crystal cell 10, the above-mentioned liquid crystal display The operation with both light analysis operations which make image light polarization which makes incident light the linearly polarized light, and light which passed along the liquid crystal layer of a liquid crystal cell 10 is given to the front-face side polarizing plate 31 arranged to the front-face side of a liquid crystal cell 10. Displaying the rear-face side polarizing plate 32 arranged to the rear-face side of a liquid crystal cell 10 without using, said rear-face side polarizing plate 32 is used as a polarizer in the case of the transparency mold display using the light from the light source 50, and it displays said front-face side polarizing plate 31 as an analyzer.
[0082] If the display action of the above-mentioned liquid crystal display is explained about the reflective mold display which uses outdoor daylight first, it will be set to this liquid crystal display. Since lagging-axis 40a of the phase contrast plate 40 is aslant shifted to transparency shaft 31a of the front-face side polarizing plate 31, The linearly polarized light which carried out incidence through said front-face side polarizing plate 31 turns into elliptically polarized light from which a polarization condition differs for every wavelength according to the birefringence effectiveness in the process which passes along the phase contrast plate 40. While carrying out incidence to the transflective reflective film M which this elliptically polarized light could change the polarization condition further according to that birefringence effectiveness in the process which passes along the liquid crystal layer of a liquid crystal cell 10, and prepared in the inside of the rear-face side substrate 11 of a liquid crystal cell 10 The light reflected by said transflective reflective film M among the light can change a polarization condition further according to such birefringence effectiveness in the process which passes along a liquid crystal layer and the phase contrast plate 40 again, and carries out incidence to said front-face side polarizing plate 31.
[0083] And since the reflected light which carries out incidence to this front-face side polarizing plate 31 is nonlinear polarization which was able to change the polarization condition according to the birefringence effectiveness of the liquid crystal layer of the above-mentioned phase contrast plate 40 and a liquid crystal cell 10, only the wavelength light of the polarization component which penetrates the front-face side polarizing plate 31 among that light penetrates and carries out outgoing radiation of this polarizing plate 31, and it turns into coloring light corresponding to the ratio of each wavelength light in this outgoing radiation light.
[0084] When the display when using the light from the light source 50 is explained, next, at this time Although the light which penetrated the transflective reflective film M which the light from the light source 50 turns into the linearly polarized light through the rear-face side polarizing plate 32, and this linearly polarized light carries out incidence to a liquid crystal cell 10 from that rear-face side, and is prepared in the inside of the rear-face side substrate 11 of a liquid crystal cell 10 among that light passes along a liquid crystal layer Since it set to the above-mentioned liquid crystal display and transparency shaft 32a of said rear-face side polarizing plate 32 is aslant shifted to direction of orientation 11a of the liquid crystal molecule on the rear-face side substrate 11 of a liquid crystal cell 10, It becomes the elliptically polarized light from which a polarization condition differs for every wavelength according to that birefringence effectiveness in a liquid crystal cell 10 in the process in which the linearly polarized light which carried out incidence from that rear-face side passes along the liquid crystal layer of this liquid crystal cell 10. This elliptically polarized light can change a polarization condition further according to that birefringence effectiveness in the process which passes along the phase contrast plate 40, and carries out incidence to the front-face side polarizing plate 31.
[0085] And since the light which carries out incidence of also at this time to the front-face side polarizing plate 31 is nonlinear polarization which was able to change the polarization condition according to the birefringence effectiveness of the liquid crystal layer of a liquid crystal cell 10, and the phase contrast plate 40, only the wavelength light of the polarization component which penetrates the front-face side polarizing plate 31 among that light penetrates and carries out outgoing radiation of this polarizing plate 31, and it turns into coloring light corresponding to the ratio of each wavelength light in this outgoing radiation light.

[0086] That is, the above-mentioned liquid crystal display is set to the reflective mold display using outdoor daylight. In the transparency mold display which colors light using polarization and a light analysis operation of the phase contrast plate 40, and the birefringence effectiveness of the liquid crystal layer of a liquid crystal cell 10 and the front-face side polarizing plate 31, and uses the light from the light source 50 Color light using the liquid crystal layer of a liquid crystal cell 10 and the birefringence effectiveness of the phase contrast plate 40, the polarization of the rear-face side polarizing plate 32, and a light analysis operation of the front-face side polarizing plate 31, and according to this liquid crystal display A very bright coloring light can be obtained compared with the liquid crystal display using the color filter generally used.

[0087] That is, although a color filter absorbs wavelength light other than the wavelength region corresponding to that color and light is colored, since this color filter also absorbs the light of the wavelength region corresponding to that color with a quite high absorption coefficient, the quantity of light of the coloring light which passed along the color filter by the liquid crystal display which colors light compared with the quantity of light of the wavelength band used as the coloring light of the light which carries out incidence to a display with the color filter decreases considerably.

[0088] the light absorption according to a color filter since the liquid crystal display of this point and the above-mentioned example is what colors light, without using a color filter -- or -- moreover, the phase contrast plate 40 and the liquid crystal 27 of a liquid crystal cell 10 hardly absorb light only by changing the polarization condition of the transmitted light.

[0089] For this reason, the quantity of light of the coloring light which can change a polarization condition according to such birefringence effectiveness, and penetrates and carries out outgoing radiation of the front-face side polarizing plate 31 The amount of the light of the wavelength band used as said coloring light of the light which carried out incidence through the front-face side polarizing plate 31 in the case of a reflective mold display, and was reflected by the above-mentioned transflective reflective film M, Or it is hardly different from the amount of the light of the wavelength band used as said coloring light of the light which carried out incidence through the rear-face side polarizing plate 32 in the case of a reflective mold display, and penetrated said transflective reflective film M, therefore the coloring light of high brightness is obtained.

[0090] Moreover, although two or more colors by one pixel were not able to be displayed in the liquid crystal display which colors light with a color filter since the foreground color was decided by the color of a color filter, according to the liquid crystal display of the above-mentioned example, two or more colors by one pixel can be displayed.

[0091] Namely, it sets to the liquid crystal display of the above-mentioned example. Although the birefringence effectiveness of the phase contrast plate 40 does not change, the birefringence effectiveness of the liquid crystal layer of a liquid crystal cell 10 In order to change with the electrode 13 of both the substrates 11 and 12, and the electrical potential differences impressed among 23 in connection with the orientation condition of a liquid crystal molecule changing, The applied voltage to a liquid crystal cell 10 can be controlled, and the color of the coloring light which will penetrate and carry out outgoing radiation of the front-face side polarizing plate 31 if the polarization condition of the light which passed along the phase contrast plate 40 and the liquid crystal layer of a liquid crystal cell 10 is changed can be changed, therefore two or more colors by one pixel can be displayed.

[0092] The display drive of this liquid crystal display in addition, fundamentally Like the display drive of the active-matrix mold liquid crystal display (what uses TFT as an active element) generally known While supplying the wave-like reference signal which synchronized with the synchronizing signal to the counterelectrode 23 of a liquid crystal cell 10, synchronizing each gate line with said synchronizing signal and supplying a gate signal to it one by one That what is necessary is just to carry out by making it synchronize with it and supplying the data signal of the potential according to image data to each data line, if the potential of said data signal is controlled according to image data The data signal of the potential according to said image data is supplied to the pixel electrode 13 through TFT14 at the selection period of the pixel of each line, and the electrical potential difference according to this data signal is impressed between the pixel electrode 13 and a counterelectrode 23.

[0093] If the foreground color of the above-mentioned liquid crystal display is explained, as mentioned above, for example The directions 11a and 12a of orientation of the liquid crystal [ a liquid crystal cell 10 carries out twist orientation of the liquid crystal molecule on about 90-degree twist square between both the substrates 11 and 12, and ] molecule on both the substrate 11 and 12, The transparency shafts 31a and 32a of polarizing plates 31 and 32 and lagging-axis 40a of the phase contrast plate 40 tended to have shown drawing 10 , respectively.

The value of deltan-d (product of refractive-index anisotropy deltan of liquid crystal 26 and the liquid crystal thickness d) of a liquid crystal cell 10 And about 980nm When the value of the retardation of (for example, deltan=0.204, d= 4.8 micrometers), and the phase contrast plate 40 is about 370nm, in the reflective mold display using outdoor daylight In the transparency mold display which the foreground color of each pixel changes to red, blue, green, black, and white according to the applied voltage to a liquid crystal cell 10, and uses the light from the light source 50, the foreground color of each pixel changes to red, green, blue, and white according to the applied voltage to a liquid crystal cell 10.

[0094] Drawing 11 and drawing 12 show change of the foreground color in the reflective mold display of the above-mentioned liquid crystal display, and the CIE chromaticity diagram and drawing 12 which show color change of outgoing radiation light [ as opposed to applied voltage in drawing 11 R> 1 ] are a rate property Fig. of electrical-potential-difference-outgoing radiation. In addition, incidence of the white light is carried out to a liquid crystal display from a 30-degree direction (bearing may be arbitrary) to the normal, and here shows the result of having observed [ of the liquid crystal display ] outgoing radiation light from the normal.

[0095] In this reflective mold display, as the color of outgoing radiation light shows the electrode 13 of a liquid crystal cell 10, and the electrical-potential-difference value impressed among 23 to drawing 11 in connection with enlarging, it changes in the direction of an arrow head, and by that middle, outgoing radiation light becomes the color of red and blue with it, green, black, and white, as shown in drawing 12 . [ high optical reinforcement and sufficient / color purity ] In addition, the outgoing radiation light of the red in this case is the red light which wore purple.

[0096] Thus, the above-mentioned liquid crystal display can also display said red, blue, green, black, and the color mixture by two or more colors of the whites by displaying a color which is different in two or more pixels which can display the color of said red, blue, green, black, and white by one pixel in the case of the reflective mold display using outdoor daylight, and adjoin.

[0097] Moreover, the CIE chromaticity diagram and drawing 14 which drawing 13 and drawing 14 show change of the foreground color in the transparency mold display of the above-mentioned liquid crystal display, and show color change of outgoing radiation light [ as opposed to applied voltage in drawing 13 ] are a rate property Fig. of electrical-potential-difference-outgoing radiation. In addition, this drawing 13 and drawing 14 also carry out incidence of the white light to a liquid crystal display from a 30-degree direction (bearing may be arbitrary) to that normal, and the result of having observed [ of the liquid crystal display ] outgoing radiation light from the normal is shown.

[0098] In this reflective mold display, as the color of outgoing radiation light shows the electrode 13 of a liquid crystal cell 10, and the electrical-potential-difference value impressed among 23 to drawing 13 in connection with enlarging, it changes in the direction of an arrow head, and by that middle, outgoing radiation light becomes the color of green [ with it / red and green ], blue, and white, as shown in drawing 14 . [ high optical reinforcement and sufficient / color purity ]

[0099] Thus, the above-mentioned liquid crystal display can also display said red, green, blue, and the color mixture by two or more colors of the whites by displaying a color which is different in two or more pixels which can display the color of said red, green, blue, and white by one pixel, and adjoin also by the reflective mold display using the light from the light source 50.

[0100] In addition, although the color picture of a different color from the case of a transparency mold display will be displayed if a liquid crystal cell 10 is driven in the case of a reflective mold display as well as the case of a transparency mold display since the foreground color and the color number corresponding to the applied voltage in this reflective mold display differ from the case of the above-mentioned transparency mold display If the drive conditions (potential of the data signal corresponding to image data etc.) of a liquid crystal cell 10 are controlled in the case of a reflective mold display, also in a reflective mold display, the color picture of the color near a transparency mold display can be displayed.

[0101] However, since it is used as a reflective mold display using outdoor daylight in almost all cases, and the above-mentioned liquid crystal display makes the light source 50 turn on and is used as a reflective mold display to see display information temporarily in a dark location with little quantity of light of outdoor daylight, Since it seldom becomes a problem, the difference in the color of the display image in a reflective mold display designs the drive conditions of a liquid crystal cell 10 on the basis of a transparency mold display, and on the same drive conditions as a transparency mold display, a liquid crystal cell 10 also drives a reflective mold display, and it may perform it.

[0102] Moreover, although the liquid crystal display of the above-mentioned example displays the color of red, blue, green, black, and white in a reflective mold display and the color of red, green,

blue, and white is displayed in a transparency mold display The directions 11a and 12a of orientation of the liquid crystal [ foreground color / of this liquid crystal display ] molecule on applied voltage, both the substrates 11 of a liquid crystal cell 10, and 12, and the twist angle of a liquid crystal molecule, Since it is decided by the direction of the transparency shafts 31a and 32a of polarizing plates 31 and 32, and the direction of lagging-axis 40a of the phase contrast plate 40, if these conditions are chosen, said foreground color can be chosen as arbitration.

[0103] and at the time of the reflective mold display which uses outdoor daylight by forming the transflective reflective film M in the inside of the rear-face side substrate 11 of a liquid crystal cell 10, the above-mentioned liquid crystal display Since it is what gives the operation with both light analysis operations which make image light polarization which makes incident light the linearly polarized light, and light which passed along the liquid crystal layer of a liquid crystal cell 10 to the front-face side polarizing plate 31, and is displayed, without using the rear-face side polarizing plate 32, Since said reflective mold display can be performed without losing the outgoing radiation quantity of light with the rear-face side polarizing plate 32 and the rear-face side substrate 11 of a liquid crystal cell 10, The quantity of light loss by the light absorption in the polarizing plate in the case of the reflective mold display using outdoor daylight and the substrate of a liquid crystal cell can be lessened, and an indication by reflective mold display can be given sufficiently bright.

[0104] In addition, in the above-mentioned liquid crystal display, although light passes also along the liquid crystal layer of the phase contrast plate 40 and a liquid crystal cell 10, as mentioned above, in order that this phase contrast plate 40 and a liquid crystal layer may hardly absorb light, there is almost no quantity of light loss by these.

[0105] Moreover, since the transflective reflective film M is formed in the inside of the rear-face side substrate 11 of a liquid crystal cell 10 in the above-mentioned liquid crystal display, Although it is difficult to use this transflective reflective film M as the diffuse reflection film, as mentioned above If the whole surface of the front-face side polarizing plate 31 arranged to the front-face side of a liquid crystal cell 10 is the light-scattering side A, since the incident light and outgoing radiation light to a liquid crystal display can be scattered in respect of [ A ] said light scattering, Even if the reflector of said transflective reflective film M is a mirror plane mostly, external images, such as a display observer's face and its background, are reflected to said reflector, and do not appear.

[0106] Furthermore, if the front face of the pixel electrode 13 which serves as the transflective reflective film M is a mirror plane mostly in the above-mentioned liquid crystal display Do not scatter the light which was able to change the polarization condition by the liquid crystal layer of a liquid crystal cell 10 in the reflective mold display with the transflective reflective film M, and it also sets to a transparency mold display. The light which carries out incidence to a liquid crystal cell 10 from the rear-face side through the rear-face side polarizing plate 32 is not scattered with the transflective reflective film M.

[0107] And in this case, if the front face of said front-face side polarizing plate 31 is the light-scattering side A After the light which carries out incidence to a liquid crystal display from the front-face side in the case of a reflective mold display is scattered about, become the linearly polarized light by the polarization of the front-face side polarizing plate 31, and also in a reflective mold display, it also sets to a transparency mold display. Since it is scattered about after the light which passed along the liquid crystal layer of a liquid crystal cell 10 turns into image light according to a light analysis operation of said front-face side polarizing plate 31, light is not scattered about, therefore a quality image can be displayed until incident light turns into image light through said front-face side polarizing plate 31.

[0108] In addition, if the scattering effect of the above-mentioned light-scattering side A is decided by the Hayes value mentioned above and this Hayes value is 25% or more Although a reflect lump of the above-mentioned external image is produced as image light and the light which became are also greatly scattered about according to a light analysis operation of the front-face side polarizing plate 31, and a display image becomes indistinct and the Hayes value is 6% or less If the Hayes value of the light-scattering side A is the range which is 9 - 14%, while obtaining a clear display image, a reflect lump of an external image can also be lost.

[0109] And in the above-mentioned liquid crystal display, since the pixel electrode 13 prepared in the inside of the rear-face side substrate 11 of a liquid crystal cell 10 is made to serve as the transflective reflective film M, the structure of a liquid crystal cell 10 can be simplified and said pixel electrode 13 and the transflective reflective film M can be formed in coincidence, preparing the transflective reflective film in the inside of the rear-face side substrate 11 of a liquid crystal cell 10, manufacture of a liquid crystal cell 10 also becomes easy.

[0110] Although TFT14 is avoided and the pixel electrode 13 which is [the 2nd example] and which serves as the transflective reflective film M in the 1st example of the above is formed, this pixel electrode 13 may cover and form said TFT14.

[0111] Drawing 15 is some sectional views of the liquid crystal display in which the 2nd example of this invention is shown. The liquid crystal display of this example It forms over the whole surface mostly. TFT14 arranged in the inside of the rear-face side substrate 11 of a liquid crystal cell 10 -- the wrap protection insulator layer 21 -- transparence insulator layers, such as Si N film, -- carrying out -- this protection insulator layer 21 -- said rear-face side substrate 11 -- It connects with 19s of source electrodes of TFT14 in contact hole 21a which covered said TFT14, formed the pixel electrode 13 which serves as the transflective reflective film M by that part on this protection insulator layer 21, and formed this pixel electrode 13 in said protection insulator layer 21.

[0112] In addition, as for this example, the formation conditions of the wrap protection insulator layer 21 and the pixel electrode 13 only differ TFT14, and since other configurations are the same as the 1st example mentioned above, to drawing, the overlapping explanation attaches a same sign and is omitted.

[0113] In addition to the effectiveness of the 1st example which could cover TFT14 by the protection insulator layer 21, and could enlarge area of the pixel electrode 13 which will serve as the transflective reflective film M if said TFT14 is covered and the pixel electrode 13 is formed on it like this example, therefore was mentioned above, the numerical aperture in the case of the reflective mold display using outdoor daylight can be gathered.

[0114] In addition, although the numerical aperture at the time of a transparency mold display is almost the same as the 1st example mentioned above since the transmitted light is interrupted in TFT14 part also in the liquid crystal display of this example in the case of the transparency mold display using the light from the light source 50 Since it is used as a reflective mold display using outdoor daylight in almost all cases as the above-mentioned liquid crystal display was mentioned above, the effectiveness which can gather the numerical aperture in the case of a reflective mold display is large.

[0115] Although the pixel electrode 13 and TFT14 are formed in the rear-face side substrate 11 of a liquid crystal cell 10 in the [3rd example] and the 1st and 2nd examples of the above, what formed the pixel electrode 13 and TFT14 in the front-face side substrate 12 is sufficient as said liquid crystal cell 10.

[0116] Drawing 16 is some sectional views of the liquid crystal display in which the 3rd example of this invention is shown. This example Two or more TFT14 which corresponds a liquid crystal cell 10 to the inside of the front-face side substrate 12 at two or more pixel electrode 13 and each [ these ] pixel electrode 13, respectively is arranged. It considers as the active-matrix mold cel which formed said each pixel electrode 13 and the counterelectrode 23 which counters in the inside of the rear-face side substrate 11. Said pixel electrode 13 is used as the transparent electrode which consists of ITO film etc., and said counterelectrode 23 is formed with either of the transflective reflective film M shown in drawing 3 and drawing 4 , drawing 5 , drawing 6 , drawing 7 , and drawing 8 .

[0117] In addition, the liquid crystal display of this example prepares the inside transparent pixel electrode 13 and inside transparent TFT14 of the front-face side substrate 12 of a liquid crystal cell 10. The counterelectrode 23 which serves as the transflective reflective film M to the inside of the rear-face side substrate 11 is formed. Since said configuration of TFT14 is the same as the thing of the 1st example mentioned above and arrangement of polarizing plates 31 and 32 and the phase contrast plate 40 is the same as said 1st example, the overlapping explanation attaches and omits a same sign to drawing.

[0118] Also in the liquid crystal display of this example, like the 1st example mentioned above with ** which can color a display, without using a color filter, can obtain bright color display, and can moreover display two or more colors by one pixel The quantity of light loss by the light absorption in the polarizing plate in the case of the reflective mold display using outdoor daylight and the substrate of a liquid crystal cell is lessened. Since the counterelectrode 23 which could give an indication by reflective mold display sufficiently bright, and was prepared in the rear-face side substrate 11 of a liquid crystal cell 10 is made to serve as the transflective reflective film M, the manufacture can be made easy while simplifying the structure of a liquid crystal cell.

[0119] Although the electrode (the 1st and 2nd examples the pixel electrode 13 and the 3rd example counterelectrode 23) prepared in the inside of the rear-face side substrate 11 of a liquid crystal cell 10 is made to serve as the transflective reflective film M in the [4th example], and the above 1st - the 3rd example It may consider as the transparent electrode with which the electrode prepared in the inside of said rear-face side substrate 11 also consists of ITO film etc., and the transflective reflective film may be prepared in the rear-face side of this electrode through a

transparent insulator layer.
[0120] Drawing 17 is some sectional views of the liquid crystal display in which the 4th example of this invention is shown. This example While considering as the active-matrix mold cel which arranged the pixel electrode 13 and TFT14 in the inside of the rear-face side substrate 11 for the liquid crystal cell 10, and formed the counterelectrode 23 in the inside of the front-face side substrate 12 Said pixel electrode 13 and counterelectrode 23 are used as the transparent electrode which consists of ITO film etc. The transflective reflective film (either of the transflective reflective film shown in drawing 3 and drawing 4 R> 4, drawing 5 , drawing 6 , drawing 7 , and drawing 8 ) M is formed in the rear-face side of said pixel electrode 13 prepared in the inside of the rear-face side substrate 11 through the gate dielectric film (transparent membrane) 16 of TFT14.
[0121] In addition, the liquid crystal display of this example uses as a transparent electrode the pixel electrode 13 prepared in the inside of the rear-face side substrate 11 of a liquid crystal cell 10, and if the point of having formed the transflective reflective film M in that rear-face side is removed, since other configurations are the same in the 1st example mentioned above, the overlapping explanation attaches and omits a same sign to drawing.
[0122] Also in the liquid crystal display of this example, a display is colored like the 1st example mentioned above, without using a color filter, bright color display is obtained, with ** which can moreover display two or more colors by one pixel, the quantity of light loss by the light absorption in the polarizing plate in the case of the reflective mold display using outdoor daylight and the substrate of a liquid crystal cell can be lessened, and an indication by reflective mold display can be given sufficiently bright.
[0123] Moreover, compensation capacitance Cs which compensates the maintenance electrical potential difference of the pixel in a non-selection period with this transflective reflective film M, said pixel electrode 13, and gate dielectric film in the meantime since the pixel electrode 13 prepared in the inside of the rear-face side substrate 11 of a liquid crystal cell 10 was used as the transparent electrode in this example and the transflective reflective film M is formed in the rear-face side of this pixel electrode 13 through transparent gate dielectric film 16 It can constitute.
[0124] In addition, said transflective reflective film M is used in this way, and it is the compensation capacitance Cs of a pixel. When it constitutes, reference potential connection Rhine is wired on said rear-face side substrate 11 (although not illustrated, it forms in the transflective reflective film M and one, for example), and the transflective reflective film M is connected to a reference potential through said reference potential connection Rhine.
[0125] As a liquid crystal cell 10, although that to which twist orientation of the liquid crystal molecule was carried out on about 90-degree twist square is used for each liquid crystal display of the 1st - the 4th example which is [Other Example(s)] and which was mentioned above The twist angle of this liquid crystal molecule was good also not only as 90 degrees but 180-270 degrees, and said liquid crystal cell 10 could change the orientation of the liquid crystal molecule further into orientation conditions, such as homogeneous orientation, a homeotropic orientation, and hybrid orientation.
[0126] Moreover, although the liquid crystal display of each above-mentioned example colors light using polarization and a light analysis operation of the phase contrast plate 40, and the birefringence effectiveness of the liquid crystal layer of a liquid crystal cell 10 and polarizing plates 31 and 32 It is a thing applicable also to the color liquid crystal display of the birefringence effectiveness mold which this invention is not equipped with said phase contrast plate 40, but colors light using polarization and a light analysis operation of the birefringence effectiveness of the liquid crystal layer of a liquid crystal cell 10 and polarizing plates 31 and 32. Also in that case, transparency shaft 31a of the front-face side polarizing plate 31 is aslant shifted to direction of liquid crystal molecular orientation 12a on the front-face side substrate 12 of a liquid crystal cell 10. If transparency shaft 32a of the rear-face side polarizing plate 32 is aslant shifted to direction of liquid crystal molecular orientation 11a on the rear-face side substrate 11 of a liquid crystal cell 10, light can be colored using polarization and a light analysis operation of the birefringence effectiveness of the liquid crystal layer of a liquid crystal cell 10 and polarizing plates 31 and 32.
[0127] However, like the above-mentioned example, if the phase contrast plate 40 is arranged between a liquid crystal cell 10 and the front-face side polarizing plate 31, when the electrical potential difference which a liquid crystal molecule starts to a liquid crystal cell 10 almost perpendicularly, and carries out orientation to it to the 11 or 12th page of a substrate is impressed (i.e., even when the birefringence effectiveness of a liquid crystal layer is almost lost seemingly), coloring light can be obtained according to the birefringence effectiveness of the phase contrast plate 40. In this case, two or more phase contrast

plates may be arranged in piles.

[0128] Furthermore, although the active-matrix mold cel was used as a liquid crystal cell 10 in each above-mentioned example, this liquid crystal cell 10 may be a simple matrix type cel, a segment display mold cel, etc.

[0129] Moreover, although the liquid crystal display of the above-mentioned example displays a color picture using the birefringence effectiveness, this invention is applicable also to the liquid crystal display of TN mold or a STN mold.

[0130]

[Effect of the Invention] At the time of the reflective mold display which uses outdoor daylight by preparing the transflective reflective film in the inside of the rear-face side substrate of a liquid crystal cell, the liquid crystal display of this invention The operation with both light analysis operations which make image light polarization which makes incident light the linearly polarized light, and light which passed along the liquid crystal layer of a liquid crystal cell is given to the 1st polarizing plate arranged to the front-face side of a liquid crystal cell. Display the 2nd polarizing plate arranged to the rear-face side of a liquid crystal cell, without using, and according to this liquid crystal display Since it can carry out without losing the outgoing radiation quantity of light with the 2nd polarizing plate which has arranged the reflective mold display using outdoor daylight to the rear-face side of a liquid crystal cell, and the rear-face side substrate of said liquid crystal cell, The quantity of light loss by the light absorption in the polarizing plate in the case of the reflective mold display using outdoor daylight and the substrate of a liquid crystal cell can be lessened, and an indication by reflective mold display can be given sufficiently bright.

[0131] Moreover, in the liquid crystal display of this invention, if the electrode prepared in the inside of a rear-face side substrate among the electrodes prepared in the inside of both the substrates of said liquid crystal cell, respectively is made to serve as said transflective reflective film, while simplifying the structure of a liquid crystal cell, the manufacture can be made easy.

[0132] Namely, when said liquid crystal cell is an active-matrix mold cel which arranged the pixel electrode and the active element in the inside of a rear-face side substrate, and prepared the counterelectrode in the inside of a front-face side substrate, [ for example, ] Make said pixel electrode serve as the transflective reflective film, and said liquid crystal cell arranges a pixel electrode and an active element in the inside of a front-face side substrate. When it is the active-matrix mold cel which prepared the counterelectrode in the inside of a rear-face side substrate That what is necessary is just to make said counterelectrode serve as the transflective reflective film, if it does in this way, since the structure of a liquid crystal cell can be simplified and said pixel electrode or counterelectrode, and the transflective reflective film can be formed in coincidence, manufacture of a liquid crystal cell will also become easy.

[0133] Moreover, said liquid crystal cell is an active-matrix mold cel which arranged the pixel electrode and the active element in the inside of a rear-face side substrate. When making said pixel electrode serve as the transflective reflective film, said active element is covered by the protection insulator layer. If may cover said active element, the pixel electrode which serves as the transflective reflective film may be prepared on said protection insulator layer, you may connect with said active element, in the contact hole formed in said protection insulator layer and it does in this way Area of the pixel electrode which serves as the transflective reflective film can be enlarged, and the numerical aperture in the case of a reflective mold display can be gathered.

[0134] In the liquid crystal display of this invention, each electrode prepared in the inside of both the substrates of said liquid crystal cell, respectively may be a transparent electrode. Furthermore, in that case Although what is necessary is just to prepare the transflective reflective film in the rear-face side of the electrode prepared in the inside of a rear-face side substrate through a transparent insulator layer For example, if said pixel electrode is used as a transparent electrode and the transflective reflective film is prepared in the rear-face side of this pixel electrode through a transparent insulator layer when said liquid crystal cell is an active-matrix mold cel which arranged the pixel electrode and the active element in the inside of a rear-face side substrate The compensation capacitance which compensates the maintenance electrical potential difference of the pixel in a non-selection period by this transflective reflective film, said pixel electrode, and the insulator layer in the meantime can be constituted.

[0135] Moreover, since the transflective reflective film is prepared in the inside of the rear-face side substrate of a liquid crystal cell in the liquid crystal display of this invention, As for using this transflective reflective film as the diffuse reflection film, although it is difficult, if the whole surface of the 1st polarizing plate arranged to the front-face side of a liquid crystal cell is a light-scattering side, even if the reflector of said transflective reflective film is a mirror plane mostly, external images, such as a display

observer's face and its background, are reflected to said reflector, and do not appear.

[0136] Furthermore, in the liquid crystal display of this invention, if the reflector of said transflective reflective film is a mirror plane mostly, the light which the light which was able to change the polarization condition by the liquid crystal layer of a liquid crystal cell in the reflective mold display is not scattered with the transflective reflective film, and carries out incidence to a liquid crystal cell from the rear-face side through the 2nd polarizing plate also in a transparency mold display will not be scattered with the transflective reflective film.

[0137] And if the front face of said 1st polarizing plate is a light-scattering side, after the light which carries out incidence to a liquid crystal display from that front-face side in the case of a reflective mold display will be scattered about in this case, become the linearly polarized light by the polarization of the 1st polarizing plate, and Moreover, since it is scattered about after the light which passed along the liquid crystal layer of a liquid crystal cell also in the transparency mold display also in the reflective mold display turns into image light according to a light analysis operation of said 1st polarizing plate, Light is not scattered about, therefore a quality image can be displayed until incident light turns into image light through said 1st polarizing plate.

[Brief Description of the Drawings]

[Drawing 1] The basic block diagram of the liquid crystal display in which the 1st example of this invention is shown.
[Drawing 2] Some expanded sectional views of this liquid crystal display.
[Drawing 3] Some of the sectional views showing the 1st example of the transflective reflective film.
[Drawing 4] The top view of the transflective reflective film shown in drawing 3 .
[Drawing 5] Some of the sectional views showing the 2nd example of the transflective reflective film.
[Drawing 6] Some of the sectional views showing the 3rd example of the transflective reflective film.
[Drawing 7] Some of the sectional views showing the 4th example of the transflective reflective film.
[Drawing 8] The top view of the transflective reflective film shown in drawing 7 .
[Drawing 9] The expanded sectional view of the front face of a front-face side polarizing plate.
[Drawing 10] The top view showing the direction of liquid crystal molecular orientation of a liquid crystal cell, the lagging axis of a phase contrast plate, and the transparency shaft of a polarizing plate.
[Drawing 11] The CIE chromaticity diagram showing color change of the outgoing radiation light to the applied voltage in the case of a reflective mold display.
[Drawing 12] The rate property Fig. of electrical-potential-difference-outgoing radiation in the case of a reflective mold display.
[Drawing 13] The CIE chromaticity diagram showing color change of the outgoing radiation light to the applied voltage in the case of a transparency mold display.
[Drawing 14] The rate property Fig. of electrical-potential-difference-outgoing radiation in the case of a transparency mold display.
[Drawing 15] The basic block diagram of the liquid crystal display in which the 2nd example of this invention is shown.
[Drawing 16] The basic block diagram of the liquid crystal display in which the 3rd example of this invention is shown.
[Drawing 17] The basic block diagram of the liquid crystal display in which the 4th example of this invention is shown.
[Drawing 18] The basic block diagram of the conventional liquid crystal display.

[Description of Notations]

10 -- Liquid crystal cell
11 -- Rear-face side substrate
12 -- Front-face side substrate
13 -- Pixel electrode
14 -- TFT (active element)
22 -- Orientation film
23 -- Counterelectrode
24 -- Orientation film
26 -- Liquid crystal
M -- Transflective reflective film
31 -- Front-face side polarizing plate (the 1st polarizing plate)
32 -- Rear-face side polarizing plate (the 2nd polarizing plate)
40 -- Phase contrast plate
50 -- Light source